APPENDIX NOT INCLUDED

SEPARATOR

54-00068

HAZ WASTE

COMPLIANCE

08/15/2000

NA

9542367

Cedar Chemical Company
Notice of Deficiencies
Risk Assessment

1. ***Executive Summary – Groundwater Chemicals of Potential Concern (COPC) may include more compounds than listed. The risk assessment omitted a table summarizing all Maximum Contaminants Levels (MCL), Risk-Based Concentration (RBC) Residential, and RBC Industrial for groundwater contaminants. Also, see comments regarding Tables 14 and 15, Page 6 Section 2.1, Areas of Concern; Recommend the "tense" of the first sentence be corrected to reflect that the Cedar facility evaluated the eight sites defined during the RFI.***

Response: The risk assessment report has been revised as suggested. This information is presented as Table 1 in the revised risk assessment report.

2. ***Page 17, Section 2.2.2: Cedar should include United States Environmental Protection Agency (USEPA) RAGS Part D as a reference in completing the risk assessment report. All of the tables included in RAGS Part D should be a part of the final risk assessment report.***

Response: Section 2.2.2 has been revised to include a reference to RAGS Part D and to indicate that all of the tables included in the draft risk assessment report were prepared in accordance with RAGS Part D requirements. Therefore, no changes to the format are warranted.

3. ***Page 18, Section 2.2.3.1: Cedar should use the latest version of EPA Region VI's Human Health Media-Specific Screening Levels (USEPA, 5/99). EPA revised these levels in 1999.***

Response: Medium-specific screening levels used in the draft risk assessment report were current at the time the report was under preparation. The latest version of the medium-specific screening levels has been incorporated into the final report.

4. ***Page 19, First Paragraph: The Arkansas Department of Environmental Quality (ADEQ) requests Cedar include the guidance from EPA Region IV that discusses converting residential tap water concentrations to industrial tap water concentrations. Cedar should exclude chemicals detected in the perched groundwater ONLY if the reported maximum concentration is LESS THAN respective MCLs. If a chemical does not have an MCL, then the RBC number is acceptable for use.***

Response: USEPA Region 4 guidance has been provided in the revised risk assessment report as Appendix C. The screening process for identifying the COPCs has been revised based on the procedure specified in the April 23, 1999 letter from ADEQ (i.e., the maximum concentration of a compound will be compared to the more stringent of MCLs or RBCs.

5. *Page 22, Section 2.2.3.4: Cedar should include the equations used to calculate the concentrations of airborne chemicals from soil in the text starting on Page 29. Recommend inserting a reference to this section in this area.*

Response: The equations used for calculating the concentrations of airborne chemicals from soil have been incorporated in Section 2.3.2 of the revised report. A reference to this section appears in Section 2.2.3.4.

6. *2.2.3.4 Identification of Transport Routes – fails to identify soils as a potential continuing source of groundwater contamination. The risk assessment Workplan in Section 3.3.4.1 required comparing subsurface concentration data to RBCs calculated by USEPA to be protective of groundwater. Cedar should consider MCLs or tap water RBCs applicable at the facility property boundary as a point of potential exposure if Cedar calculates site specific values. Cedar may elect to evaluate other scenarios in addition to drinking water at the property line if so desired.*

Response: Subsurface soils were compared to site-specific SSLs that were calculated using the MCL or tapwater MSSL as the target concentration. A site-specific DAF was calculated using hydrogeological information presented in the Cedar Chemical Corporation Facility Investigation (EnSafe, 1996).

7. *Page 22, Section 2.2.4: MTCAStat (Version2.1) is unknown to the Risk Assessment Section. Request Cedar submit additional information on the software in the text or the risk assessment report.*

Response: Section 2.2.4 has been revised to indicate that MTCAStat is software developed by the State of Washington Department of Ecology for statistical evaluation (e.g., determining data distribution, calculating the mean and 95% upper confidence limit of the arithmetic mean). Copies of supporting documents that have been published by the State of Washington Department of Ecology have been provided in Appendix D of the revised report. A copy of the software can be obtained at the State of Washington Department of Ecology website (http://www.wa.gov/ECOLOGY/tcp/mtcastat.html).

8. *Page 24, Section 2.3.1.1, Climate: Recommend the insertion of specific climatological data for Phillips County in the text of this report.*

Response: Climatological data specific for Helena, Philips County has been presented in Section 2.3.1.1 as suggested.

9. *Page 24, Section 2.3.1.1, Groundwater Uses on-site: Provide the source(s) of West Helena and Helena's water supply.*

Response: Both the cities of Helena and West Helena, Arkansas obtained water from the Sparta Sand aquifer. This aquifer is 400 feet below ground surface and is not connected to the alluvial aquifer. This information has been added to Section 2.3.1.1.

10. ***Page 24, Section 2.3.1.1, Groundwater Uses off-site: Cedar last conducted a well survey in 1995. Cedar should include updated information to reflect current usage needs in the final risk assessment report. What other uses, besides drinking water usage, are the residential wells being used for (i.e., water garden/lawn, washing car, etc.).***

Response: The residential wells that were identified in the 1995 well survey were reviewed to determine whether any additional uses could be identified. Based on data from the 1995 survey and the August 2000 follow-up survey, there are no known residential uses for this water. All wells are nonfunctional. Information has been added to Section 2.3.1.1 to indicate the condition of the wells and whether residents are on city water.

11. ***2.3.1.1 Physical Setting – The alluvial aquifer has been recognized regionally as a Class I drinking water aquifer despite current uses discussed in the RA. Cedar should clarify what portion of the aquifer would require risk management for controlling use of the resource.***

Response: Concentrations of VOCs volatilizing from alluvial groundwater were re-evaluated to determine an air concentration that might be encountered by receptors present in the closest agricultural field. Emission rates were calculated as presented in Section 2.3.2. This rate was then used in the USEPA Screen Version 3 model to determine air concentrations. Cumulative carcinogenic risks calculated using these new values, which are based on maximum concentrations in alluvial groundwater, are below 1E-04 and total noncarcinogenic risks are 8. Cumulative risk and total noncarcinogenic risk estimated using average detected concentrations, which are more likely to occur, are below 1E-04 and 1, respectively. Based on this evaluation, risks are within acceptable levels and there are no portions of the aquifer that require risk management..

12. ***2.3.1.2 Exposure Points – ADEQ considers the offsite exposure point for groundwater at the property boundary as a drinking water source. Cedar should clarify the area and mechanisms in place to limit exposure to contaminated groundwater.***

Response: Residents within a 2-mile radius of Cedar Chemical Corporation are on city water and have been on city water for at least 20 years. City water is obtained from the Sparta Sand aquifer, which is not connected to the alluvial aquifer and does not receive water from it. Based on information from the City of Helena, any new construction (residential or industrial) in this 2-mile area would use city water as the water source.

13. ***2.3.1.3 Exposure Pathways – Cedar should consider the offsite exposure pathway for groundwater to be the property boundary as a drinking water source. Cedar submitted no evidence in support of limiting usage to agriculture or industrial as a reasonably***

anticipated land use. Considering agriculture fields are adjacent to other industry in the area, surrounding industrial workers and possibly residents could also be exposed to contaminants released during agricultural use depending on wind direction.

Response: Alluvial groundwater is not a source of drinking water for offsite and onsite receptors. Both onsite and offsite receptors receive water from the cities of Helena and West Helena, Arkansas. Both cities obtain water from the Sparta Sand aquifer, which is not connected to alluvial aquifer and will not receive contaminants from it.

Industrial workers may be exposed to contaminants released during agricultural use. However, the offsite agricultural worker scenario presented in the risk assessment reflects the most likely and most conservative estimate of exposure. Industrial worker exposure would be considerably less than the offsite agricultural worker because site workers are not at the point of exposure (agricultural fields). Any VOCs emanating from alluvial groundwater during irrigation activities are expected to be significantly reduced at the site worker exposure point. Therefore this pathway is not evaluated for the Cedar Chemical risk assessment.

14. 2.3.2 Fate and Transport Modeling – An exposure based upon one acre of land is not consistent with the actual agricultural operations known to be present. Considerably more acreage and volumes of irrigation water would actually be used than what was assumed for modeling.

Response: See response to Comment 11.

The method used to estimate VOCs in air has been revised to determine the air concentration at the closest agricultural field using USEPA Screen Version 3 model. The closest field was used because it represents the area where the air concentration might be the highest.

15. 3.3.3 Potentially Exposed Populations – Exposure to offsite industrial workers and residents could potentially occur due to airborne contaminants released from groundwater used for irrigation, depending on wind direction. No evidence is presented to indicate that residential development is prohibited through existing zoning enforced by the city. Surrounding industrial workers adjacent to agricultural use and residents were not considered in the risk assessment. Much of the existing industry is surrounded by agricultural use.

Response: The report has been revised to justify the exclusion of off-site residents and workers based on the following consideration:

- It is unlikely that the surrounding property will be developed for residential use in the foreseeable future based on census data for the cities of Helena and West Helena (U.S. Department of Commerce, 2000). Based on population estimates for the years 1990 to 1998, it is not likely that either city will experience drastic increases in population. Therefore, it is not likely that county agricultural land will be rezoned as residential.

	7/1/98 Estimated Population	7/1/97 Estimated Population	7/1/96 Estimated Population	7/1/95 Estimated Population	7/1/94 Estimated Population	7/1/93 Estimated Population	7/1/92 Estimated Population	7/1/91 Estimated Population	7/1/90 Estimated Population	4/1/90 Census Population
Helena city, AR	6970	7081	7069	7158	7237	7261	7279	7307	7475	7491
West Helena city, AR	9443	9576	9639	9742	9835	9841	9855	9896	10114	10137

Source: Population Estimates Program, Population Division, U.S. Census Bureau, Washington, DC 20233, Internet Release Date: June 30 1999

- Risk associated with off-site residential exposure is expected to be significantly lower than risk calculated for onsite receptors.

16. 2.5.6.2 Exposure Assessment Uncertainties – The groundwater inhalation pathway does not include surrounding industrial workers. The Blackhawk irrigation well was reported to be contaminated (1600 ppb 1,2-dichloroethane) and was known to be used for watering the lawn in the Facility Investigation Report, June 1996. Plant uptake is not considered in the RA. Food chain crops are currently grown in the exposure area. Recommend that the RA reflect actual use.

Response: **Groundwater inhalation pathway**: See response to comment 13.

Risk associated with watering lawn: Risk associated with this pathway is expected to be significantly lower than that calculated for the irrigation pathway already presented in the report.

Plant uptake: Additional text has been added to the report to explain why ingestion of plants was not considered a viable pathway. Crops growing in agricultural fields surrounding Cedar Chemical might potentially uptake contaminants via three mechanisms: direct deposition of particles, vapor transfer, or root uptake. Because contamination is limited to VOCs that volatilize from irrigation water, root uptake and direct deposition of particles is minimal. However, there is the possibility for plant uptake via vapor transfer. Because chemicals detected in alluvial groundwater at Cedar Chemical are volatile organic compounds that have low bioaccumulation factors, it is unlikely that these chemicals will be incorporated into plant tissue (USEPA, 1998). Additionally, these food crops are subject to additional processing and mixing with uncontaminated food; therefore, the amount of chemicals that would be ingested by any receptor is considerably lower than the concentration that might have been incorporated into the plant. Homegrown produce might also be considered a potential exposure pathway. However, the main source of contamination would be through watering with alluvial groundwater from contaminated wells. Because these private wells are not operable, exposure to contaminated homegrown produce is not a complete exposure pathway.

17. ***2.5.6.3 Toxicity Assessment Uncertainties – Provide evidence that the site and surrounding properties are likely to remain industrial or agricultural as a future land use City zoning, deed restrictions, binding agreements (such as a lease) with landowners, etc., could be used to support this contention.***

Response: Cedar Chemical Corporation, the adjacent industrial facilities, and agricultural properties are located in Phillips County, which does not have zoning laws or regulations. Census data collected between 1990 and 1998 indicate that this area is not experiencing and is not expected to experience drastic population increases. Therefore, rezoning current agricultural properties as residential is not likely to occur in the foreseeable future. The text of the report has been report has been revised to include this information, census data has been added to Appendix E, and a land use map has been added as Figure 12.

18. ***Table E14: Provide additional clarification for selecting an exposure frequency of 93.75 days/year for Site 4. Please provide this clarification for all other applicable tables related to Site 4.***

Response: This exposure frequency assumes the site worker is present at this site 3 hours per day rather than 8 hours per day: $(0.375 \times 250$ days/year = 93.75 days/year). This information has been provided in Table G13.

19. ***Table 14 – Screening Toxicity Values failed to use the more stringent of MCLs or RBC on all COPCs as previously directed in the 4-23-99 letter (Attachment 1 item 2) conditionally approving the Risk Assessment Work Plan. Recommend correction of the following:***

	MCL	*RBC*	
Barium	***2000***	***5110***	***retain as COPC based upon Max. exceeding MCL***
Cadmium	***5***	***36.5***	***retain as COPC based upon Max. exceeding MCL***
Chromium	***100***	***365***	***retain as COPC based upon Max. exceeding MCL***
Lead	***15***	***30***	***retain as COPC based upon Max. exceeding MCL***
Mercury	***2***	***21.9***	***retain as COPC based upon Max. exceeding MCL***
Selenium	***50***	***365***	***retain as COPC based upon Max. exceeding MCL***
Methoxychlor	***40***	***365***	***retain as COPC based upon Max. exceeding MCL***
Dinoseb	***7***	***73***	***retain as COPC based upon Max. exceeding MCL***
Chlorobenzene	***100***	***158***	***still not COPC based upon Max.***
Toluene	***1000***	***2894***	***still not a COPC based upon Max.***
Trichloroethene	***5***	***6.56***	***retain as COPC based upon Max. exceeding MCL***

Response: The screening process has been revised in accordance with the procedure (i.e., the more stringent of MCLs or RBCs) described in the Work Plan.

20. Table 15 – Screening Toxicity Values failed to use the more stringent of MCLs or RBC on all COPCs as previously directed in the 4-23-99 letter (Attachment 1 item 2) conditionally approving the Risk Assessment Workplan. It appears that the Screening Toxicity Values used are based upon the air pathway and no other pathway is considered. The Screening Toxicity Value refers to footnote 3 that states the values are ambient air screening values (ug/m^3) from EPA Region 6. According to Section 2.2.3.1 of the risk assessment, Cedar should calculate screening values by taking Region 6 residential tap water values and dividing by 0.25 for VOCs or dividing by 0.5 for all other chemicals. Recommend correction of the table as follows:

	MCL	*RBC*	
1,2 Dichloroethane	*5*	*0.58*	*retain as COPC based upon Max. exceeding RBC*
Ethylbenzene	*700*	*1059*	*still not COPC based upon Max.*

Response: The screening process has been revised as suggested.

21. Table 31 – Footnotes 2 and 3 missing from table.

Response: Footnotes 2 and 3 will be added to Table 31 as suggested.

22. Table 32 – Footnotes 3 missing from table. This table does not represent all volatile COCs carried through to Table 33. Revise the table to include all volatile COCs.

Response: Footnote 3 has been added to Table 32 as suggested. Screening values will be selected as suggested and any revisions to the COPC selected will be incorporated.

23. Table 33 – Average concentration values for 1,2-dichloroethane are not consistent with Table 32. Clarify the average concentration values represented in the model input. Inhaled concentration units (mg/m^3) modeled were used as ug/m^3 in Table 91A. The table should include screening values and the selection of COCs carried through the process.

Response: Concentrations have been corrected as suggested.

24. Table 79A – Average concentration values for 1,2-dichloroethane are not consistent with Table 32. Clarify the average concentration values represented. All COCs were not carried through from Table 32.

Response: The concentrations presented have been revised and updated as necessary.

25. Table 79B – Inconsistent units from previously calculated values were used in the Route EPC column. The Maximum Inhaled Concentration calculated on Table 33

were reported in ppm and were used in Table 79 in ppb. Determine if it is a typographical area or if recalculation is necessary and revise the table accordingly.

Response: The units have been reviewed and updated as necessary.

26. Table 79C – See comments to Table 79B. The calculated values are carried through.

Response: This table has been revised, as necessary, to reflect changes to Table 79B.

27. Table 80 – Footnote 1 is missing from the table.

Response: Footnote 1 has been added to the table.

28. Tables 91A, B and C – COCs may have been prematurely omitted due to the inconsistent use of units noted in comments to Table 33. Screening Route EPC values may be three orders of magnitude off.

Response: The data were screened using the more stringent of MCLs or RBCs. These tables include the COPCs selected after this screening.

29. Appendix F, Threatened and Endangered Species: The report from the Arkansas Natural Heritage Commission indicates two Federal Listed Endangered Species and one Federal Listed Threatened Species within Phillips County. Recommend further ecological investigation take place to determine whether a more in-depth ecological risk assessment is warranted (i.e., do these three species reside on or near the Cedar site?).

Response: There are no suitable habitats on Cedar Chemical Corporation property for the species identified in the report completed by the Arkansas Natural Heritage Commission. Two of the listed species occur in and along the Mississippi River and the third occurs along the Mississippi and White Rivers. The Arkansas Natural Heritage Commission has reviewed there files and database for a 1-mile radius surrounding the site. All current records indicate that no occurrence of rare plant and animals, outstanding natural communities, natural or scenic rivers, or other elements of special concern were found. The Arkansas Natural Heritage Commission report is included in Appendix H of the revised report.

30. The Alluvial aquifer is generally recognized as a drinking water aquifer in numerous publications. Groundwater screening values derived for industrial onsite use may not be protective of surrounding water use as contaminants continue to migrate from soils to perched water to the Alluvial aquifer offsite. Documentation is not presented demonstrating that surrounding land use is restricted by the local zoning authority. Residential use should be assumed to be a future land use unless mechanisms are in place to prohibit development. Cedar must show the areas that groundwater use is or can be restricted.

Response: Phillips County has no zoning regulations. However census data indicate that Helena and West Helena are not likely to experience large population increases; therefore it is not likely that agricultural land will be rezoned as residential. Current residents and industrial facilities receive drinking water from the cities of Helena and West Helena water supply system. Future residential developments, if any, would also obtain water from the city water system.

31. ***Subsurface soils were screened with industrial soil screening criteria rather than the migration from soils to groundwater pathway, which is typically more stringent. The COCs selected may under represent contaminants likely to be continuously released to the groundwater media. The Facility Investigation defined areas where contamination is present. Samples not contaminated and thus outside of defined areas appear to be included in some of the statistical calculations for Upper Confidence Level (UCL) and arithmetic mean. Cedar should further clarify how data sets are grouped and evaluated. For example, is it really appropriate to include subsurface samples from 30 feet below ground-surface in calculating the statistic used in the industrial exposure scenario, or is it appropriate to use an arithmetic mean based upon one detect out of twelve?***

Response: The methodology used for grouping the data set has been revised to examine depths to 10 feet below ground surface for the construction worker scenario. This depth is considered the maximum depth to which construction workers might be exposed to contaminants in subsurface soil.

Reported quantitation limits for nondetects were examined for MSSL exceedances. Quantitation limits exceeding the MSSL were assigned a proxy value of one half the quantitation limit. Values below the MSSLs were removed from the calculation of the 95% upper confidence limit. For small data sets (less than 10 sample results) risk was calculated based on the maximum concentration.

The text of this section has been revised to explain the methodology used for data evaluation and developing exposure point concentrations.

RISK ASSESSMENT

CEDAR CHEMICAL CORPORATION
WEST HELENA, ARKANSAS

EnSafe Project Number:
2162-012

Volume I — Sections 1-6

Prepared for:

Cedar Chemical Corporation
West Helena, Arkansas

Prepared by:

ENSAFE

EnSafe Inc.
5724 Summer Trees Drive
Memphis, Tennessee 38134
(901) 372-7962

August 15, 2000

Table of Contents

List of Figures

List of Appendices

Acronyms and Symbols Frequently Used in This Report

ADEQ	Arkansas Department of Environmental Quality
ABS	absorption factor
AF	adherence factor
ARAR	applicable or relevant and appropriate requirement
AT	averaging time
bgs	below ground surface
BW	body weight
C_w	concentration in water
CCC	Cedar Chemical Corporation
CF	conversion factor
cm^2	square centimeters
COC	chemical of concern
COPC	chemical of potential concern
CR	contact rate
CRAVE	Carcinogen Risk Assessment Verification Endeavor
CT	central tendency
dC/dt	change in VOC concentration over time
DI	daily intake
ECPC	ecological chemical of potential concern
ED	exposure duration
EF	exposure frequency
EPC	exposure point concentration
ERA	ecological risk assessment
ER-L	effects range-low
ET	exposure time
H_c	Henry's law constant
HEAST	Health Effects Assessment Summary Tables
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
kg	kilogram
kg/L	kilogram per liter
L/day	liter per day

MCL	maximum contaminant level
m	meter
m/sec	meter per second
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
μg/mg	micrograms per milligram
mg/day	milligrams per day
mg/kg	milligram per kilogram
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
m^3/day	cubic meters per day
MSSL	medium-specific screening level
MTCA	Model Toxic Control Act
m^2/sec	square meters per second
mm	millimeters
moles/ft^2-lb	moles per square feet pound
N	number of samples
N_A	molar flux
N/A	not applicable
NOAEL	no observed adverse effects level
NPDES	National Pollution Discharge Elimination System
OSWER	Office of Solid Waste and Emergency Response
P	total pressure
p_A	partial pressure
$(p_b)_{lm}$	log mean of air pressure
ppb	parts per billion
ppm	parts per million
PQL	practical quantitation limit
PRE	Preliminary Risk Evaluation
psi	pounds per square inch
P_{vp}	air vapor pressure
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RfC	reference concentration
RfD	reference dose
RFI	RCRA Facility Investigation
RGO	remedial goal option
RME	reasonable maximum exposure

SF	slope factor
SQB	sediment quality benchmark
SQC	sediment quality criteria
SQL	sample quantitation limit
SSL	soil screening level
SSV	sediment screening value
SWMU	solid waste management unit
UCL	upper confidence limit
USEPA	United States Environmental Protection Agency
VF	volatilization factor
VOC	volatile organic compound

EXECUTIVE SUMMARY

This report presents results of the baseline human health risk assessment (HHRA) and ecological risk assessment conducted for the Cedar Chemical Corporation (CCC) facility in West Helena, Arkansas. The objective of the site-specific risk assessment was to evaluate any potential impacts to human health and the environment associated with chemicals that have been detected in soil, sediment, and groundwater at the site.

This baseline risk assessment is divided into two parts — one addressing human health risk, and the other assessing ecological risk.

Site History

CCC is an active chemical manufacturing facility in Phillips County, Arkansas, south of West Helena, Arkansas. The site consists of approximately 48 acres along State Highway 242, one mile southwest of the intersection of U.S. Highway 49 and Highway 242. Figure 1 presents a vicinity map for the site.

Prior to 1970, the CCC plant site was cultivated farmland. In 1970, Helena Chemical Company acquired the site to construct a Propanil manufacturing facility. In 1971, the newly constructed plant was sold to J.A. Williams, who in turn transferred the plant to Eagle River Chemical Corporation, a newly formed Arkansas corporation, which was initially controlled by the Ansul Company. Under Ansul's management, the plant was converted to the production of dinitrobutylphenol, also known as dinoseb. In late 1972, Ansul sold its majority stock interest in Eagle River Chemical Corporation back to the corporation, leaving J.A. Williams as the sole shareholder. Eagle River Chemical Corporation was subsequently merged into Vertac Chemical Corporation. Vertac operated the plant until CCC acquired the site in 1986.

The facility consists of six production units and support facilities, an office on the north side of Industrial Park Road, and a biological treatment system south of the road. The entire CCC facility is fenced with controlled access. Active processes are conducted on approximately 20 acres. The rest of the site houses the biological treatment ponds and closed surface impoundments, or is unoccupied.

Risk Assessment Summary

For the HHRA, the CCC facility was evaluated based on the eight sites (Sites 1 to 6, 8, and 9) that were defined during the RCRA Facility Investigation (RFI). The sites were grouped based on the exposure setting and chemicals detected.

The overall framework used in this HHRA is based on information presented in the *Risk Assessment Work Plan* (EnSafe, 1998), which follows approved USEPA guidance outlined in Section 2.2.2 of this report.

For this HHRA, soil and sediment data were evaluated by site, while groundwater is evaluated separately as either perched groundwater or alluvial groundwater. The list of chemicals detected in site media selected for inclusion in the quantitative human health risk assessment was obtained by: (1) comparison of site-related data to risk-based screening levels or ARARs and (2) comparison to site-related background concentrations, when available.

Chemicals of potential concern (COPCs) identified for soil and sediment at each of the eight sites are presented below.

Site	Surface Soil	Surface and Subsurface Soil	Sediment
Site 1	arsenic, dieldrin, 1,2-dichloroethane	arsenic, dieldrin, 1,2-dichloroethane	arsenic, chromium
Site 2	aldrin, dinoseb	arsenic, chromium, mercury, aldrin, dieldrin, 1,2-dichloroethane, chloroform, methylene chloride	NS
Site 3	NS	dinoseb	arsenic, aldrin, dieldrin, toxaphene, pentachlorophenol
Site 4	dieldrin, dinoseb	arsenic, dieldrin, dinoseb, 3,4-dichloroaniline, 1,2-dichloroethane	NS
Site 5	NS	There were no COPCs identified.[a]	NS

Site	Surface Soil	Surface and Subsurface Soil	Sediment
Site 6	arsenic, aldrin, dieldrin, methoxychlor, toxaphene, dinoseb	NS	NS
Site 8	There were no COPCs identified.	NS	NS
Site 9	heptachlor, dinoseb, 3,4-dichloroaniline, Propanil	arsenic, dinoseb, 3,4-dichloroaniline, Propanil	NS

Notes:
NS = Not sampled.
All sample depths for Site 5 exceed 10 feet. No receptors contact soil at depths below 10 feet.

COPCs identified for perched groundwater are: arsenic, barium, cadmium, chromium, lead, 4,4'-DDT, alpha-BHC, 2,6-dinitrotoluene, 3,4-dichloroaniline, 4-chloroaniline, bis (2-chloroethyl) ether, dinoseb, 1,2-dichloroethane, 4-methyl-2-pentanone, acetone, benzene, chloroform, methylene chloride, and trichloroethene.

COPCs identified for alluvial groundwater are: 1,1,2-trichloroethane, 1,2-dichlorobenzene, 1,2-dichloroethane, 1,2-dichloropropane, acetone, benzene, bromodichloromethane, bromoform, chlorobenzene, chloroform, dibromochloromethane, methylene chloride, 4-methyl-2-pentanone, and toluene.

Because chemicals in soil may migrate into the underlying aquifer, maximum detected concentrations in soil were compared to site-specific soil screening levels. Soil screening levels (SSLs) are used to determine the potential for chemicals in soil to migrate to groundwater.

Because SSLs do not address variables such as natural attenuation, the results of this screening are only a general indicator that migration will occur. The screening results indicate that the only chemicals likely to migrate to groundwater are volatile organic compounds (VOCs): 1,2-dichloroethane, bis(2-chloroethyl)ether, chloroform, and methylene chloride. Based on alluvial groundwater data, the only groundwater detections are the VOCs identified. Although the

SSL data indicate that other contaminants may migrate to groundwater, this has not occurred. VOCs in alluvial groundwater will be quantitatively evaluated in the HHRA.

Screening perched groundwater data with SSLs indicates that the contaminant detections that exceed the medium-specific screening level (MSSL) are: 1,2-dichloroethane, alpha-BHC, bis(2-chloroethyl) ether, dinoseb, chloroform, and methyl chloride. Although the perched groundwater data indicate that chemicals have migrated, these chemicals are not likely to migrate to the alluvial aquifer because the two aquifers are not connected. All chemicals exceeding the SSL and detected in perched groundwater will be quantitatively evaluated in the HHRA.

Risk was evaluated for the following receptors and exposure pathways using guidance provided in *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual* (RAGS Part A) (USEPA, 1989).

Receptors	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Site Workers	Air, Inhalation of gaseous contaminants released from soil	Yes	It is assumed that site workers will inhale gaseous contaminants from soil.
	Air, Inhalation of chemicals entrained in fugitive dust	Yes	It is assumed that site workers will inhale fugitive dust.
	Air, Inhalation of gaseous contaminants released from alluvial groundwater	No	Alluvial groundwater is not a water source at CCC.
	Surface Soil, Incidental ingestion	Yes	It is assumed that site workers will ingest incidental amounts of soil.
	Surface Soil, Dermal contact	Yes	It is assumed that site workers will have dermal contact with soil.
Offsite Workers	Air, Inhalation of gaseous contaminants released from alluvial groundwater	No	Alluvial groundwater is not a general or drinking water source at neighboring facilities. Site workers are either not present or within enclosed spaces during irrigation.
Future Land Uses			
Site Workers	Air, Inhalation of gaseous contaminants released from soil	Yes	It is assumed that site workers will inhale gaseous contaminants from soil.
	Air, Inhalation of chemicals entrained in fugitive dust	Yes	It is assumed that site workers will inhale fugitive dust.
	Air, Inhalation of gaseous contaminants released from alluvial groundwater	No	Alluvial groundwater is not a water source at CCC. Site workers at CCC are either not present or within enclosed spaces during irrigation events.
	Surface Soil, Incidental ingestion	Yes	It is assumed that site workers will ingest incidental amounts of soil.

Receptors	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Future Land Uses (cont'd)			
Site Workers (cont'd)	Surface Soil, Dermal contact	Yes	It is assumed that site workers will have dermal contact with soil.
Offsite Workers	Air, Inhalation of gaseous contaminants released from alluvial groundwater	No	Alluvial groundwater is not a general or drinking water source at neighboring facilities. Site workers are either not present or within enclosed spaces during irrigation.
Future Onsite Construction Workers	Air, Inhalation of gaseous contaminants released from soil	Yes	It is assumed that construction workers will inhale gaseous contaminants from soil.
	Air, Inhalation of chemicals entrained in fugitive dust	Yes	It is assumed that construction workers will inhale fugitive dust.
	All soil depths, Incidental ingestion	Yes	It is assumed that site workers will ingest incidental amounts of soil.
	All soil depths, Dermal contact	Yes	It is assumed that site workers will have dermal contact with soil.
	Sediment, Incidental ingestion	Yes	It is assumed that site workers will ingest incidental amounts of sediment.
	Sediment, Dermal contact	Yes	It is assumed that site workers will have dermal contact with sediment.
Future Onsite Construction Workers	Perched groundwater, Incidental ingestion	Yes	It is assumed that site workers will ingest incidental amounts of perched groundwater.
	Perched groundwater, Dermal contact	Yes	It is assumed that site workers will have dermal contact with perched groundwater.
Future Offsite Agricultural Workers	Air, Inhalation of gaseous contaminants released from alluvial groundwater	Yes	It is conservatively assumed that farmers may inhale VOCs emanating from alluvial groundwater.
Future Site Trespassers (Adolescents, 7 through 16 years old)	Air, Inhalation of gaseous contaminants released from soil	Yes	It is assumed that trespassers will inhale gaseous contaminants from soil.
	Air, Inhalation of chemicals entrained in fugitive dust	Yes	It is assumed that trespassers will inhale fugitive dust.
	Surface Soil, Incidental ingestion	Yes	It is assumed that trespassers will ingest incidental amounts of soil.
	Surface Soil, Dermal contact	Yes	It is assumed that trespassers will have dermal contact with soil.
	Sediment, Incidental ingestion	Yes	It is assumed that trespassers will ingest incidental amounts of sediment.
	Sediment, Dermal contact	Yes	It is assumed that site workers will have dermal contact with sediment.

Results of Risk Characterization

Except for alluvial groundwater exposure for the offsite agricultural worker, cancer risk for all of the scenarios investigated for perched groundwater, sediment, and soil exposures have cumulative cancer risks for all pathways of less than 1E-04. Offsite worker cancer risks and noncarcinogenic risk for all receptors are discussed in the following sections.

Offsite Agricultural Worker

Groundwater carcinogenic risk for alluvial groundwater is 7E-04. The primary contributors to carcinogenic risk for alluvial groundwater are 1,2-dichloroethane (5E-04) and methylene chloride (2E-04).

Noncarcinogenic risks exceeding unity for the offsite agricultural worker exposure to airborne VOCs are 1,2-dichloroethane and toluene.

Construction Worker

Hazard quotients (HQs) for several sites exceed unity (i.e., greater than 1), suggesting that COPCs may pose adverse noncarcinogenic impact to receptors evaluated in the HHRA. The construction worker soil exposures exceed unity in perched groundwater and at Sites 2, 3, 4, and 9. The primary contributor to the soil HQ is dinoseb at Sites 3 and 9, 3,4-dichloroaniline at Site 4, and 1,2-dichloroethane at Site 2. 4-Chloroaniline, 3,4-dichloroaniline, 1,2-dichloroethane, and methylene chloride are the primary contributors to HQ for perched groundwater.

Adult Worker

Noncarcinogenic risks exceed unity (i.e., greater than 1) for the adult worker exposed to dinoseb and propanil in surface soil at Site 9.

Trespasser

Noncarcinogenic risks with an HQ greater than 1 for the trespasser include dinoseb and propanil at Site 9.

Chemicals of Concern Identified by Site and Media

A contaminant was selected as a chemical of concern (COC) if its cancer risk (CR) exceeded 1E-6 or it had an HQ greater than 1. For CCC sites, the COCs are listed below by site and media:

Site	Surface Soil	Subsurface Soil	Sediment
1	None	None	Arsenic
2	None	1,2-Dichloroethane	NA
3	NA	Dinoseb	None
4	None	3,4-Dichloroaniline, Dinoseb	NA
6	None	NA	NA
9	Dinoseb, Propanil	Dinoseb, Propanil	NA
Perched Groundwater		4-Chloroaniline, 3,4-Dichloroaniline, 1,2-Dichloroethane, Methylene chloride	
Alluvial Groundwater		Benzene, Chloroform, Methylene Chloride, 1,2-Dichloroethane, Toluene, 1,1,2-Trichloroethane	

Results of Central Tendency Evaluation

Where reasonable maximum exposure (RME) risk estimates indicated a CR greater than 1E-4 or an HQ greater than 1, central tendency (CT) analyses were performed. The CT analysis uses the arithmetic mean concentration as the EPC and 50th percentile exposure assumptions, consistent with guidance in *Exposure Factor's Handbook* (USEPA, 1997). Central tendency exposures are presented for comparison to risks associated with RME exposure.

A CT evaluation was completed for the following sites, media, and chemicals.

Construction Worker: Noncarcinogenic risks calculated using CT exposure assumptions for the construction worker exposed to surface and subsurface soil are less than 1 at Sites 2, 3,and 9. Noncarcinogenic risks to 3,4-dichloroaniline in perched groundwater and 3,4-dichloroaniline and dinoseb in surface and subsurface soil at Site 4 are greater than 1.

Adult Worker: Using CT exposure assumptions noncarcinogenic risks for dinoseb at Site 9 remain greater than 1. No chemicals exhibiting carcinogenic effects exceeded the 1E-04 threshold for this receptor.

Receptor	Site	Media	Chemicals
Construction Worker	1 & 2	Perched Groundwater	4-Chloroaniline, 3,4-Dichloroaniline, 1,2-Dichloroethane, Methylene chloride
	3	Surface and Subsurface Soil	Dinoseb
	4	Surface and Subsurface Soil	3,4-Dichloroaniline, Dinoseb
	9	Surface and Subsurface Soil	Dinoseb, Propanil
Adult Worker	9	Surface Soil	Dinoseb, Propanil
Trespasser	9	Surface Soil	Dinoseb, Propanil
Offsite Agricultural Worker	—	Alluvial Groundwater	Methylene chloride, 1,2-Dichloroethane, Toluene

Trespasser: Using CT exposure assumptions noncarcinogenic risks remain greater than 1 for dinoseb. No chemicals exhibiting carcinogenic effects exceeded the 1E-04 threshold for this receptor.

Offsite Agricultural Worker: Noncarcinogenic risks estimated for the offsite agricultural worker exposed to VOCs released from alluvial groundwater using CT exposure assumptions are less than . Carcinogenic risk is 5E-05 and the primary contributor to risk is 1,2-dichloroethane. Howeve,r the risk of 5E-05 is within the USEPA threshold range.

Conclusions

Alluvial groundwater risks based on RME exposure assumptions for the offsite agricultural worker represent the highest carcinogenic risks to human receptors contacting contaminated media associated with CCC.

Noncarcinogenic risk based on RME for all receptors is substantially high, based primarily on offiste agricultural worker exposure to 1,2-dichloroethane in alluvial groundwater, construction worker exposures to dinoseb in surface and subsurface soil at Sites 3 and 9, and trespasser and site worker exposure to dinoseb at Site 9.

For ecological receptors, potential risk in Area I is considered acceptable because these ditches are integral components of the facility's waste water treatment system. Because of the function of these ditches, standing water is frequently drained and any aquatic habitat is considered opportunistic. The isolated wetland in Area II is not considered at risk because the exposure pathway is incomplete. Risk to receptors in Area III from exposure to contaminated alluvial groundwater from irrigation farm practices is considered minimal based on the lack of receptors and the high volatility of 1,2-dichloroethane.

Remedial Goal Options

Remedial goal options (RGOs) are site-specific chemical concentrations used by risk managers during the development of remedial alternatives and are calculated to equate with specific target carcinogenic and noncarcinogenic risk levels. For CCC, RGOs were calculated for chemicals having an incremental lifetime cancer risk greater than 1E-6 or an HQ greater than 1. In accordance with USEPA Region IV Supplemental Guidance (USEPA, 1995a), RGOs were calculated at 1E-6, 1E-5, and 1E-4 risk levels for carcinogenic COCs and HQ levels of 0.1, 1, and 3 for noncarcinogenic COCs for all applicable media. Inclusion in the RGO table does not necessarily indicate that remedial action will be required to address a specific chemical. Instead, RGOs are provided to facilitate risk-management decisions. RGOs for these chemicals are provided in Tables 90-96.

1

1.0 INTRODUCTION

This report presents results of the baseline human health risk assessment (HHRA) and ecological risk assessment conducted for the Cedar Chemical Corporation (CCC) facility in West Helena, Arkansas. The objective of the site-specific risk assessment was to evaluate any potential impacts to human health and the environment associated with chemicals that have been detected in soil, sediment, and groundwater at the site.

Site-specific information and sampling results from the following reports have been used in to perform this risk assessment:

- Interim Response Work Plan, Cedar Chemical Corporation, West Helena, Arkansas. EnSafe, 1995b.

- Facility Investigation Cedar Chemical Corporation — FINAL. EnSafe, 1996.

- Risk Assessment Work Plan, Cedar Chemical Corporation. EnSafe, 1998.

- Laboratory results analyzed by Paradigm Analytical Laboratories, Inc. September 1995, October 1995, November 1995, January 1996, April 1996, November 1996, March 1997, July 1997, and August 1997.

- Laboratory results analyzed by IT Corporation. September 1993.

- Laboratory results analyzed by American Interplex November 1994, December 1994, and January 1995.

- Biomonitoring results for Cedar Chemical Corporation by American Interplex calendar year 1998 and 1999.

For ease of use, all tables generated for risk calculation and remedial goal options (RGOs) (i.e., Tables 1 to 96) are presented in Appendix A.

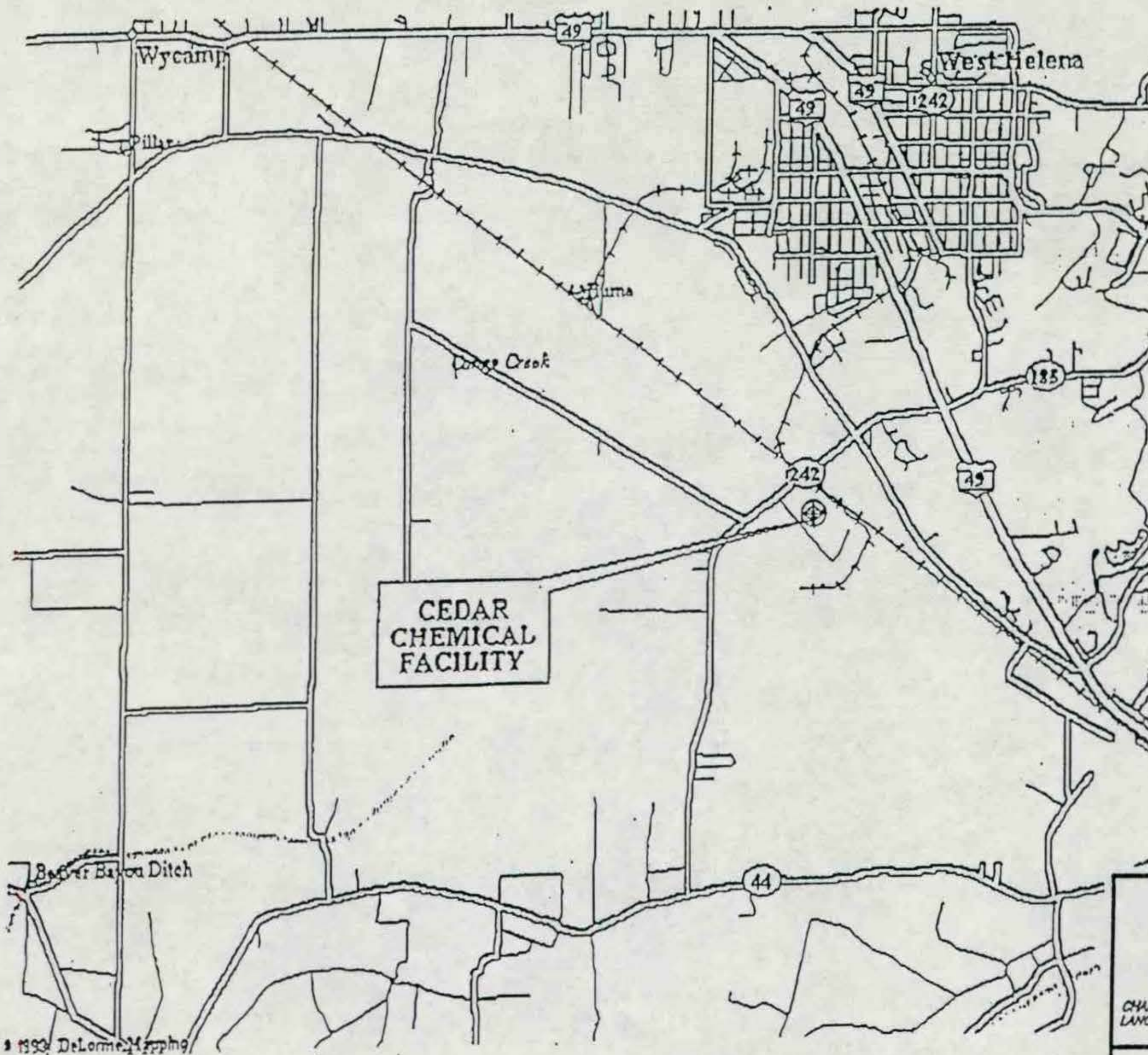
1.1 Site Condition

CCC is an active chemical manufacturing facility in Phillips County, Arkansas, just south of West Helena, Arkansas. The site consists of approximately 48 acres along State Highway 242, one mile southwest of the intersection of U.S. Highway 49 and Highway 242. Figure 1 presents a vicinity map for the site.

CCC consists of six production units and support facilities, an office on the north side of Industrial Park Road, and a biological treatment system south of the road. The entire facility is fenced with controlled access. Active processes are conducted on approximately 20 acres. The rest of the site houses the biological treatment ponds and closed surface impoundments, or is unoccupied.

1.2 Site History

Prior to 1970, the CCC plant site was cultivated farmland. In 1970, Helena Chemical Company acquired the site to construct a Propanil manufacturing facility. In 1971, the newly constructed plant was sold to J.A. Williams, who in turn transferred the plant to Eagle River Chemical Corporation, a newly formed Arkansas corporation which was initially controlled by the Ansul Company. Under Ansul's management, the plant was converted to the production of dinitrobutylphenol, also known as dinoseb. In late 1972, Ansul sold its majority stock interest in



ENSAFE

(800) 588-7962
MEMPHIS, TENNESSEE
CHARLESTON, SC CINCINNATI, OH DALLAS, TX JACKSON, TN KNOXVILLE, TN
LANCASTER, PA NASHVILLE, TN NORFOLK, VA PADUCAH, KY PENSACOLA, FL
RALEIGH, NC COLOGNE, GERMANY

FIGURE 1
VICINITY MAP
CEDAR CHEMICAL
RISK ASSESSMENT

DWG DATE: 08/05/99	DWG NAME: BOARD

Eagle River Chemical Corporation back to the corporation, leaving J.A. Williams as the sole shareholder. Eagle River Chemical Corporation was subsequently merged into Vertac Chemical Corporation. Vertac operated the plant until CCC acquired the site in 1986.

Solid wastes generated during the period before Vertac's operation are largely unknown. It should be noted that formulation processes vary because of the contract nature of the agricultural chemical business. However, the manufacturing segment is routine and not subject to substantial variation.

1.3 Present Site Operations

CCC, which employs approximately 125 people, manufactures various agricultural chemicals including insecticides, herbicides, polymers, and organic intermediates. Plant processes are batch operations with seasonal production fluctuations and constant product introductions. CCC manufactures its own products (such as Propanil, a rice herbicide) and also custom manufactures chemicals for contract clients. Formulation and packaging are ancillary activities, and are conducted only when the product is ready for the consumer market.

The facility consists of six production units. Unit 1 formulates various custom agricultural products for other companies. Unit 2 is the Propanil production unit. Unit 3 was destroyed in a fire and explosion on September 26, 1989. Unit 4 produces various custom products. Unit 5 primarily manufactures nitroparaffin derivatives. In 1991, Unit 6 began producing dichloroaniline, which is used in the production of Propanil. Figure 2 presents a facility map.

2

2.0 HUMAN HEALTH RISK ASSESSMENT

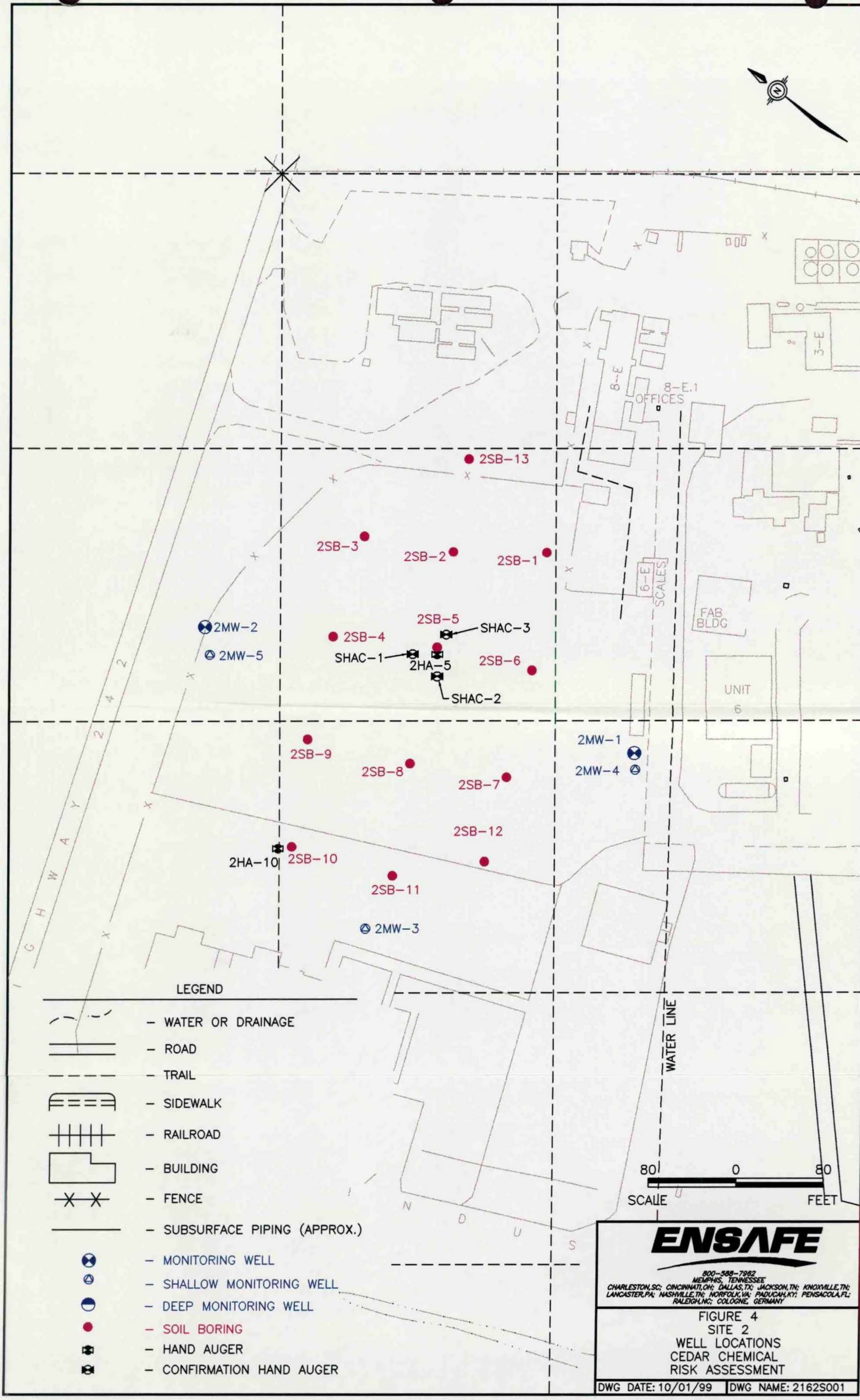
Most baseline risk assessments are divided into two parts — one addressing human health risk, and the other assessing ecological risk. This section assesses human health risk at CCC. Ecological risk is assessed in Section 3. Methods used to reach the conclusions of this HHRA are discussed in the following sections.

2.1 Areas of Concern

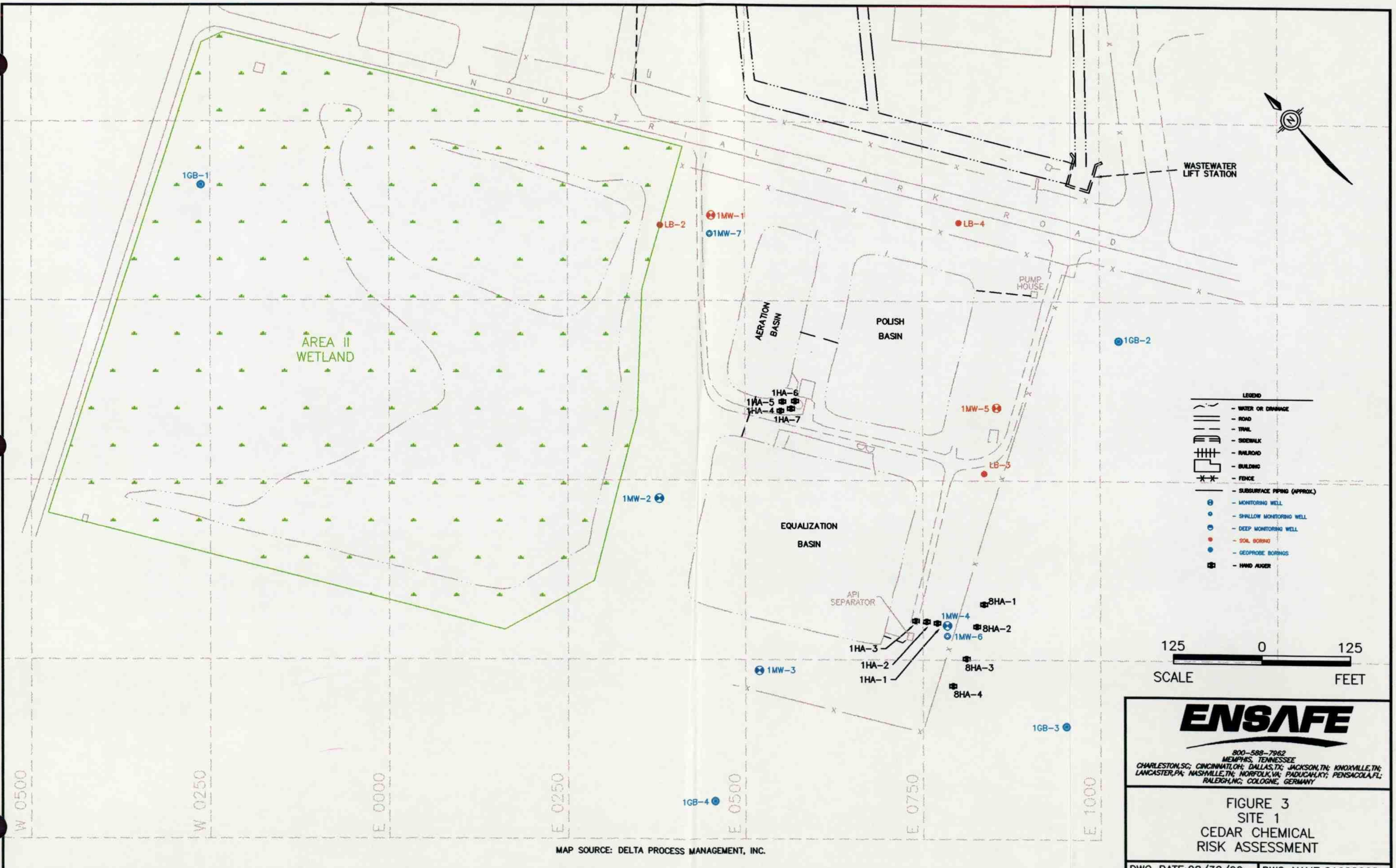
For the HHRA, the CCC facility was evaluated based on the eight sites that were defined during the RCRA Facility Investigation (RFI). The sites were grouped based on the exposure setting and chemicals detected. Each site and its use are described below.

Site 1: Site 1, presented in Figure 3, includes four solid waste management units (SWMUs): Wastewater Tank 2 (SWMU 63), the Flow Equalization Basin (SWMU 64), the Aeration Basin (SWMU 65), and the Polish Pond (SWMU 68), that are part of the wastewater treatment system. The treatment system is in the southeast corner of the site across Industrial Park Road. Perched groundwater was encountered at approximately 12 feet below ground surface (bgs).

Site 2: SWMUs 69, 70, and 71 (Figure 4) are part of a three-pond wastewater treatment system used from 1970 to 1978. In 1978, the ponds were drained by a disposal contractor and filled with soil from the CCC property. Ponds 1 and 2 were approximately 120 feet × 150 feet × 10 feet deep and Pond 3 was approximately 30 feet × 150 feet × 4 feet deep. The unlined units were constructed of earthen fill. Pond 3 also contained limestone for acid neutralization. The units received wastes from onsite production processes and some wastes generated offsite until 1978; wastes included propionic acid, calcium chloride solution, and neutralized sulfuric acid waste. This list does not include the wastes disposed of at this site by Helena Chemical Company. Helena formulated 100 to 200 compounds, any of them could have been disposed of in these ponds. Currently Site 2 has gravel, sparse vegetation, and dirt as ground cover. Perched groundwater was encountered approximately 12 feet beneath this site.



2SB-13
2SB-3
2SB-2
2SB-1
2SB-5
SHAC-3
2MW-2
2SB-4
2MW-5
SHAC-1
2HA-5
2SB-6
SHAC-2
2SB-9
2SB-8
2SB-7
2MW-1
2MW-4
2SB-12
2HA-10
2SB-10
2SB-11
2MW-3
8-E
8-E.1
OFFICES
3-E
6-E
SCALES
FAB BLDG
UNIT 6
WATER LINE
HIGHWAY 242
INDUS
LEGEND
- WATER OR DRAINAGE
- ROAD
- TRAIL
- SIDEWALK
- RAILROAD
- BUILDING
- FENCE
- SUBSURFACE PIPING (APPROX.)
- MONITORING WELL
- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- SOIL BORING
- HAND AUGER
- CONFIRMATION HAND AUGER
80 0 80
SCALE FEET
ENSAFE
800-588-7962
MEMPHIS, TENNESSEE
CHARLESTON,SC; CINCINNATI,OH; DALLAS,TX; JACKSON,TN; KNOXVILLE,TN; LANCASTER,PA; NASHVILLE,TN; NORFOLK,VA; PADUCAH,KY; PENSACOLA,FL; RALEIGH,NC; COLOGNE, GERMANY
FIGURE 4
SITE 2
WELL LOCATIONS
CEDAR CHEMICAL
RISK ASSESSMENT
DWG DATE: 10/01/99
DWG NAME: 2162S001



MAP SOURCE: DELTA PROCESS MANAGEMENT, INC.

ENSAFE

800-588-7962
MEMPHIS, TENNESSEE
CHARLESTON,SC; CINCINNATI,OH; DALLAS,TX; JACKSON,TN; KNOXVILLE,TN; LANCASTER,PA; NASHVILLE,TN; NORFOLK,VA; PADUCAH,KY; PENSACOLA,FL; RALEIGH,NC; COLOGNE, GERMANY

FIGURE 3
SITE 1
CEDAR CHEMICAL
RISK ASSESSMENT

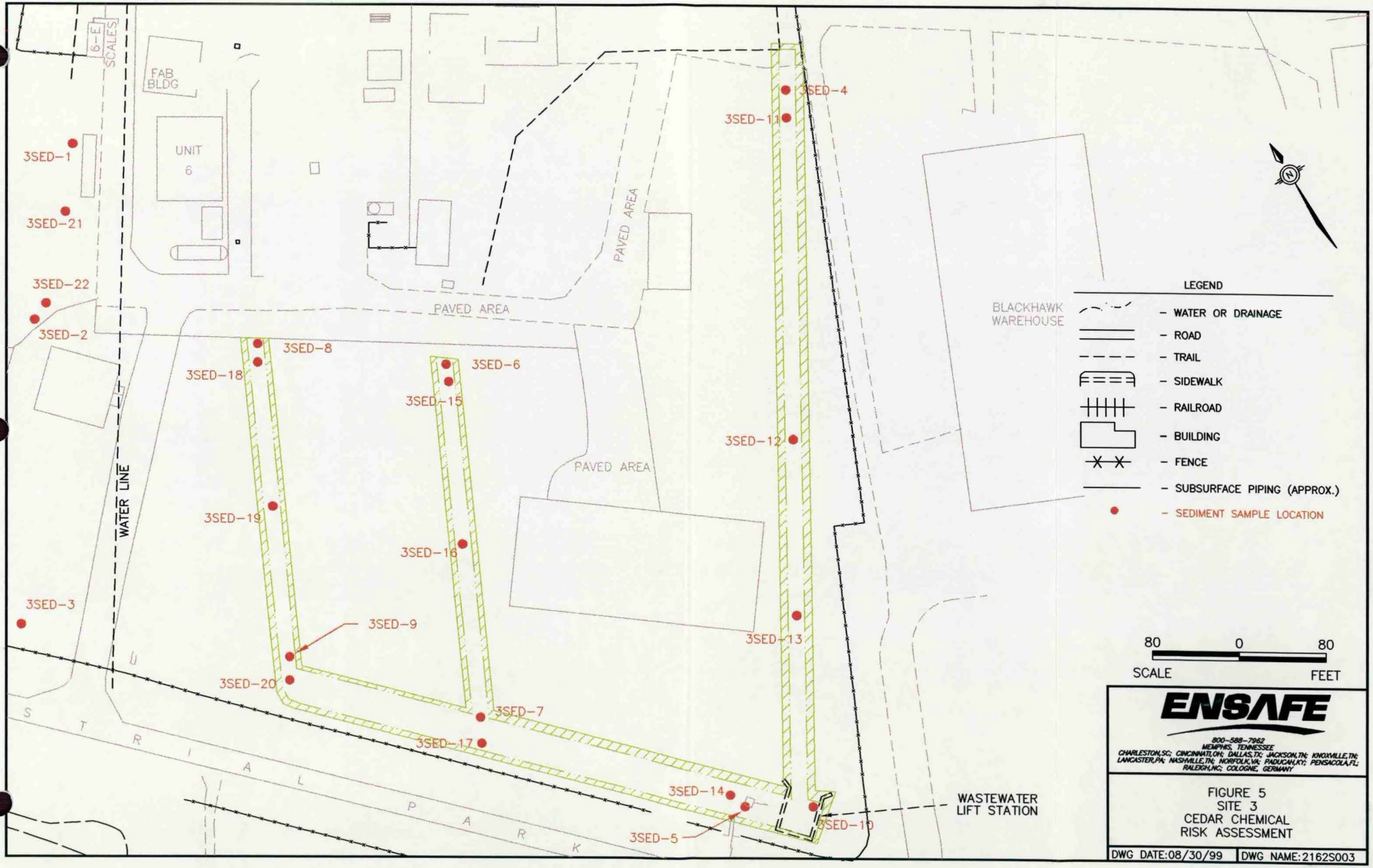
DWG DATE:08/30/99 | DWG NAME:2162S002

Site 3: Site 3, presented as Figure 5, includes two SWMUs which constitute the storm water drainage system. All storm water runoff at the facility is collected in four storm water ditches (SWMU 59), which flow through the interior of the property to the southwest. These ditches all drain into a larger storm water ditch adjacent to Industrial Park Road. This larger ditch flows south into the storm water sump (SWMU 60), formerly the storm water pond. The contents of the sump are periodically pumped into the wastewater treatment system directly across Industrial Park Road.

Site 4: Site 4, presented as Figure 6, includes two SWMUs, the railroad loading and unloading area (SWMU 74), and an abandoned railroad loading and unloading sump (SWMU 3). Both SWMUs are in an area between the railroad spur and the main tank farm where raw materials and final products are transferred between the tank farm and railroad cars. Staining in this area indicated that releases may have occurred during past transfer operations. Currently this site has gravel and sparse vegetation as ground cover.

Site 5: This unit is a concrete vault with walls of poured concrete, a subfloor of gravel, sand, and possibly cement, and a concrete cap, which forms the floor of the warehouse onsite. In addition to fill sand and gravel, the vault contains approximately 250 drums of solidified, low-grade herbicide, which did not meet product specifications. It is thought that the drums were placed in the vault in early 1976. Site 5 is presented as Figure 7.

Site 6: Site 6 (Figure 8) includes several areas of the plant where yellow staining is visible, particularly after rain, indicating the presence of dinoseb. The staining appears to be dispersed across the nonproduction area of Site 6, with some areas more heavily stained than others.



6-E SCALES
FAB BLDG
UNIT 6
PAVED AREA
PAVED AREA
PAVED AREA
BLACKHAWK WAREHOUSE
WATER LINE
S T R I A L P A R K
3SED-1
3SED-2
3SED-3
3SED-4
3SED-5
3SED-6
3SED-7
3SED-8
3SED-9
3SED-10
3SED-11
3SED-12
3SED-13
3SED-14
3SED-15
3SED-16
3SED-17
3SED-18
3SED-19
3SED-20
3SED-21
3SED-22
WASTEWATER LIFT STATION
LEGEND
- WATER OR DRAINAGE
- ROAD
- TRAIL
- SIDEWALK
- RAILROAD
- BUILDING
- FENCE
- SUBSURFACE PIPING (APPROX.)
- SEDIMENT SAMPLE LOCATION
80 0 80
SCALE FEET
ENSAFE
800-588-7962
MEMPHIS, TENNESSEE
CHARLESTON,SC; CINCINNATI,OH; DALLAS,TX; JACKSON,TN; KNOXVILLE,TN; LANCASTER,PA; NASHVILLE,TN; NORFOLK,VA; PADUCAH,KY; PENSACOLA,FL; RALEIGH,NC; COLOGNE, GERMANY
FIGURE 5
SITE 3
CEDAR CHEMICAL
RISK ASSESSMENT
DWG DATE:08/30/99
DWG NAME:2162S003

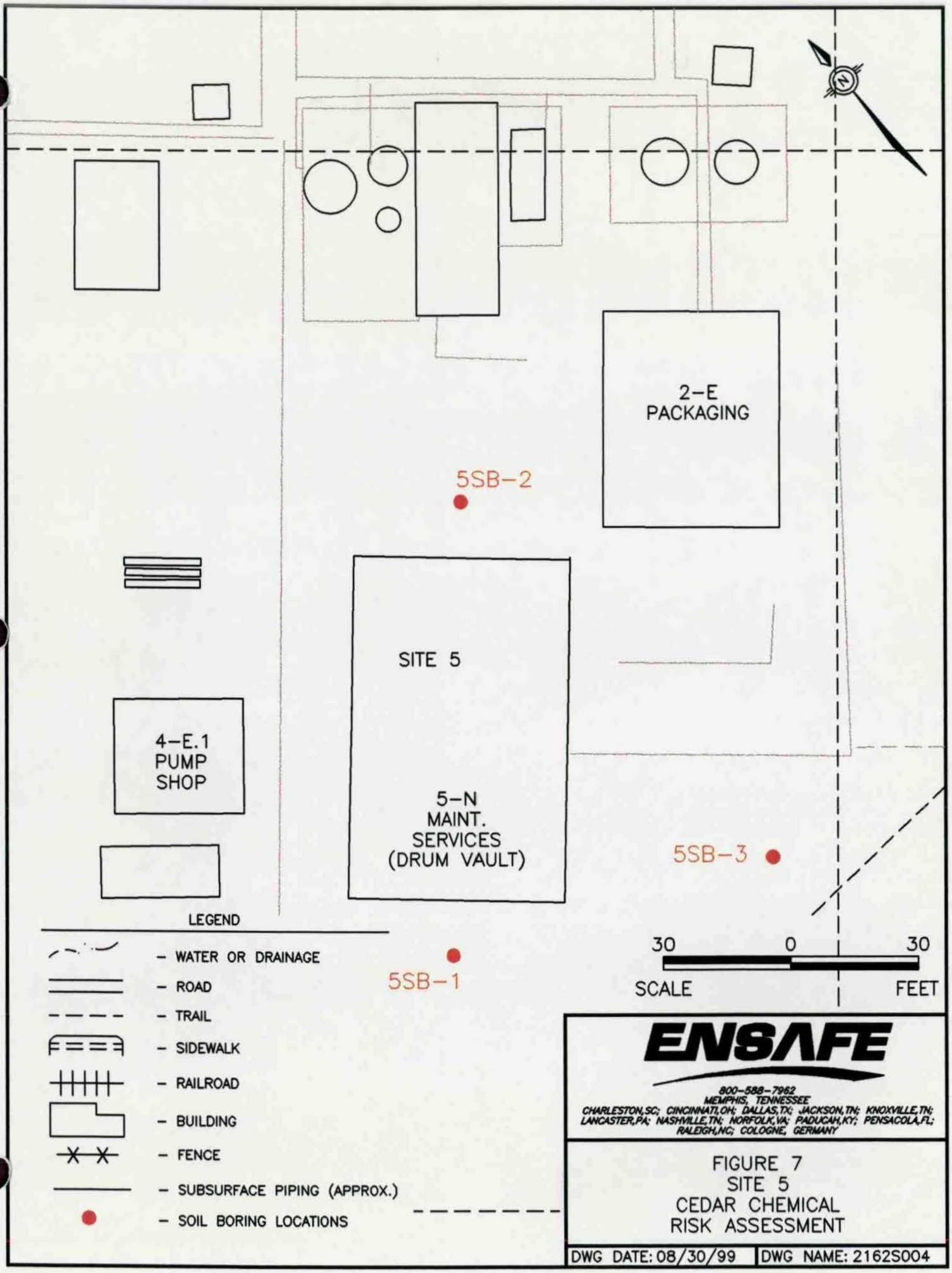


FIGURE 7
SITE 5
CEDAR CHEMICAL
RISK ASSESSMENT

DWG DATE: 08/30/99 | DWG NAME: 2162S004

ENSAFE

800-588-7962
MEMPHIS, TENNESSEE
CHARLESTON,SC; CINCINNATI,OH; DALLAS,TX; JACKSON,TN; KNOXVILLE,TN; LANCASTER,PA; NASHVILLE,TN; NORFOLK,VA; PADUCAH,KY; PENSACOLA,FL; RALEIGH,NC; COLOGNE, GERMANY

FIGURE 8
SITE 6
CEDAR CHEMICAL
RISK ASSESSMENT

DWG DATE: 08/30/99 | DWG NAME: 2162S006

Site 8: Site 8 (Figure 9) is a ditch on the south side of the wastewater treatment ponds. In the past, the API separator would overflow and wastewater destined for the treatment ponds would flow into the industrial park ditch to the White River. To remediate this problem, the separator and pad were cleaned and a gutter was installed in February 1992. The gutter was designed to divert all overflow into the equalization pond. The contaminated soil in the ditch was also removed, placed in drums, and sent to the Chemical Waste Management Subtitle C landfill in Carlyss, Louisiana; however, no confirmatory sampling of the ditch was performed. All storm water is currently discharged to NPDES Outfall No. 002 via the treatment ponds.

Site 9: Site 9 (Figure 10) consists of three suspected abandoned ponds in the area between the dichloroaniline unit and the maintenance services building (Site 5). The ponds are reported to have been shallow, unlined basins used to dispose of off-specification dinoseb. The ponds are no longer used and have since been backfilled. Buildings have been constructed near the ponds and some areas have been paved or covered with gravel.

2.2 Data Collection and Evaluation

This section summarizes analytical data collected for the site, identifies chemicals of potential concern (COPCs), and determines chemical-specific concentrations to be used in the risk assessment.

2.2.1 Historical Data Evaluation

This section summarizes results of investigations conducted for CCC. Several sampling investigations have been completed for the CCC property. During these investigations, groundwater, sediment, and soil were sampled for Resource Conservation and Recovery Act (RCRA) metals, pesticides, and polychlorinated biphenyls, semivolatile organic compounds, and volatile organic compounds (VOCs). However,

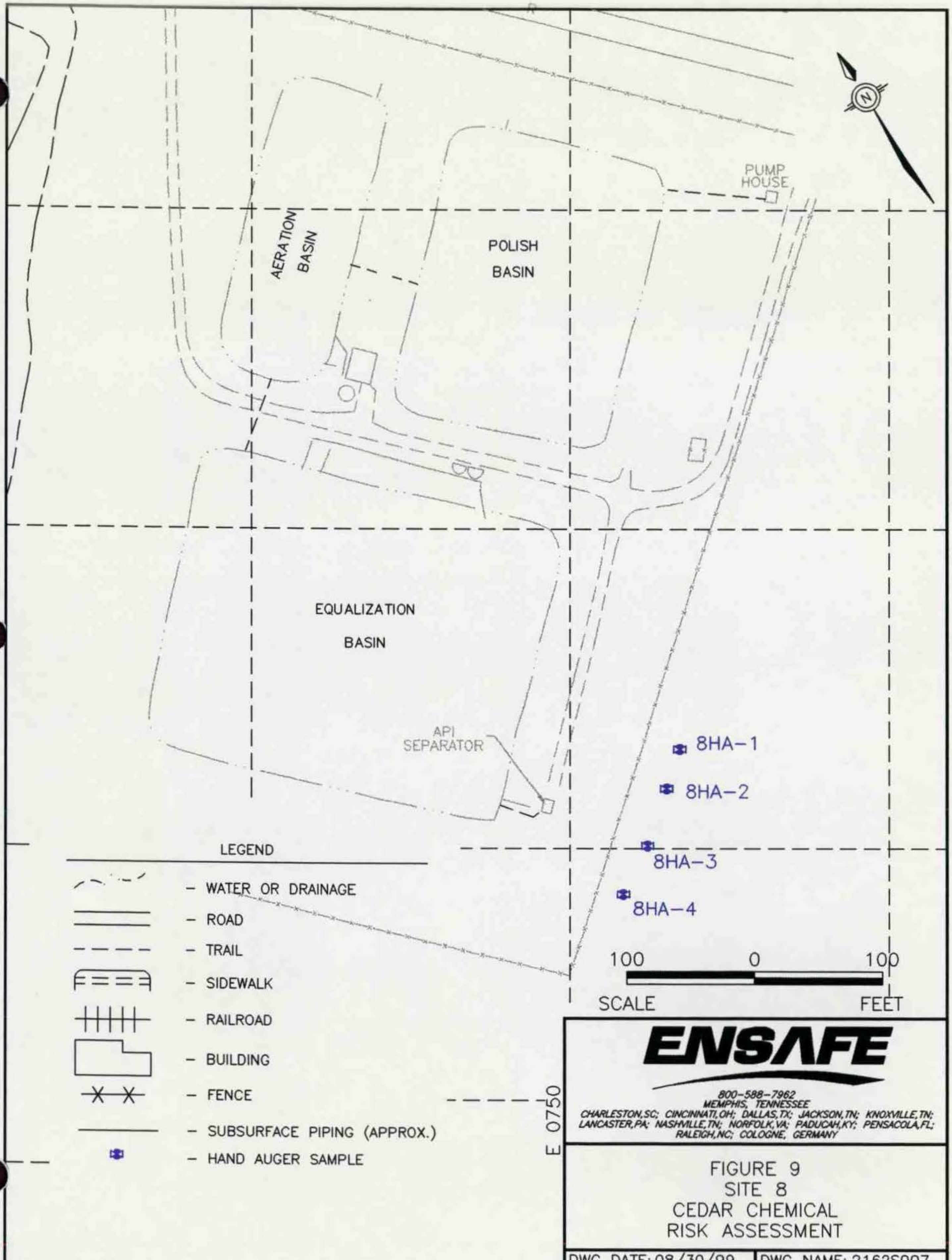
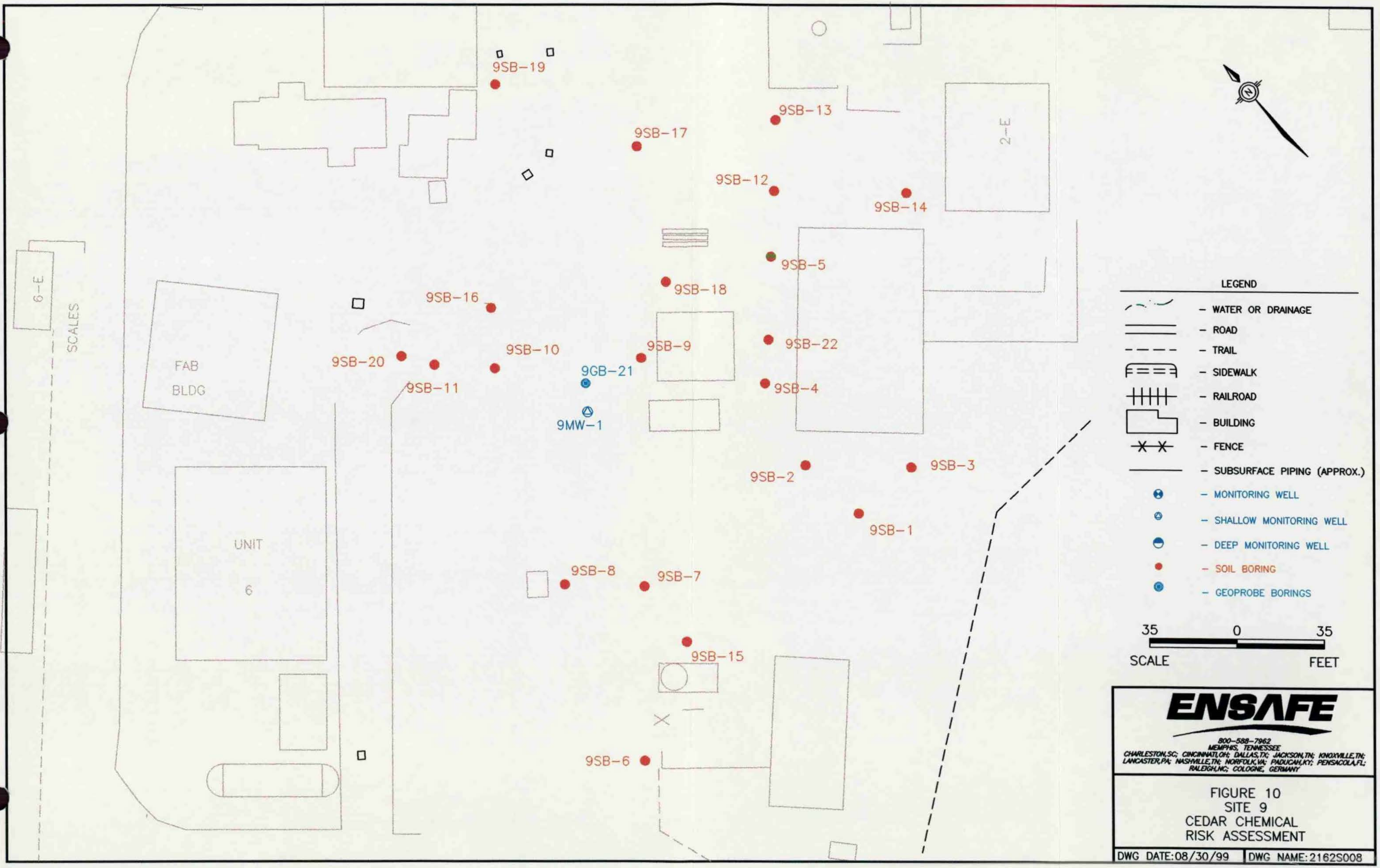


FIGURE 9
SITE 8
CEDAR CHEMICAL
RISK ASSESSMENT



9SB-19
9SB-13
9SB-17
9SB-12
9SB-14
2-E
6-E
SCALES
9SB-5
9SB-18
9SB-16
FAB
BLDG
9SB-10
9SB-9
9SB-22
9SB-20
9GB-21
9SB-11
9SB-4
9MW-1
9SB-2
9SB-3
UNIT
6
9SB-1
9SB-8
9SB-7
9SB-15
9SB-6
LEGEND
- WATER OR DRAINAGE
- ROAD
- TRAIL
- SIDEWALK
- RAILROAD
- BUILDING
- FENCE
- SUBSURFACE PIPING (APPROX.)
- MONITORING WELL
- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- SOIL BORING
- GEOPROBE BORINGS
35
0
35
SCALE
FEET
ENSAFE
800-588-7962
MEMPHIS, TENNESSEE
CHARLESTON,SC; CINCINNATI,OH; DALLAS,TX; JACKSON,TN; KNOXVILLE,TN; LANCASTER,PA; NASHVILLE,TN; NORFOLK,VA; PADUCAH,KY; PENSACOLA,FL; RALEIGH,NC; COLOGNE, GERMANY
FIGURE 10
SITE 9
CEDAR CHEMICAL
RISK ASSESSMENT
DWG DATE:08/30/99
DWG NAME:2162S008

not all parameters were analyzed for each sampling investigation. Sampling events and parameters analyzed to develop this HHRA are detailed in the RCRA Facility Investigation report (EnSafe, 1996). Additional surface soil samples were collected at Site 2 to determine if the arsenic detection of 98.1 parts per million (ppm) was an anomaly. Three samples were collected approximately 10 to 40 feet from soil boring 2SB-5 (Figure 4). The analytical data from these locations were considered discrete samples for screening. Because the additional samples did not confirm the original detection of 98.1 ppm, the high detection was considered an anomaly and not used for screening or calculating the concentration used to quantitate risk.

All analytical data used in this baseline risk assessment is presented in Appendix B.

2.2.2 Scope of Work for Risk Assessment

The overall framework used in this HHRA is based on information presented in the Risk Assessment Work Plan (EnSafe, 1998) which uses approved USEPA guidance:

- *Risk Assessment Guidance for Superfund (RAGS), Volume I — Human Health Evaluation Manual (Part A)*, (RAGS Part A) (USEPA, 1989).

- *RAGS, Volume I — Human Health Evaluation Manual, Supplemental Guidance — Standard Default Exposure Factors — Interim Final,*(USEPA, 1991).

- *RAGS, Volume I — Human Health Evaluation Manual, Supplemental Guidance — Dermal Risk Assessment — Interim Guidance*,(USEPA, 1992a).

- *RAGS, Volume 1 — Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments) — Interim* (USEPA, 1998).

- *Supplemental Guidance to RAGS: Calculating the Concentration Term* (USEPA, 1992b).

- *Supplemental Guidance to RAGS: Region IV Bulletins*, (USEPA Region IV, 1995a).

- *Screening Method for Estimating Inhalation Exposure to Volatile Chemicals from Domestic Water*. (USEPA, 1995b).

- *Exposure Factors Handbook* (USEPA, 1997a).

- *USEPA Region VI Human Health Medium-Specific Screening Levels,* (MSSLs) (USEPA Region VI, May 1999).

- *Guidance on Preliminary Risk Evaluations (PREs) for the Purpose of Reaching a Finding of Suitability to Lease* (USEPA, 1994).

2.2.3 Identification of Chemicals of Potential Concern

Analytical results for all media are summarized in the RFI (EnSafe, 1996) for groundwater, sediment, and soil. The following briefly reviews criteria used to identify COPCs for CCC.

For this HHRA, soil and sediment data were evaluated by site, while groundwater is evaluated separately as either perched or alluvial. The list of chemicals detected in site media was reduced by comparing site-related data to risk-based screening levels and site-related background concentrations, when available.

2.2.3.1 Comparison of Data to Risk-based Screening Values

The maximum detected concentrations were compared to MSSLs provided in USEPA Region VI Human Health Media-Specific Screening Levels (May 1999). As stated in the USEPA Region VI document, MSSLs were based on a risk goal of 1E-06 for carcinogenic effects and a hazard quotient (HQ) of 1 for noncarcinogenic effects. The sections that follow describe additional screening elements for each media.

Perched Groundwater

As recommended by the Arkansas Department of Environmental Quality (ADEQ), groundwater data were screened against the more stringent of the following values: either USEPA Drinking Water Standards (MCLs) or risk-based screening values adjusted for the industrial-use scenario. Because USEPA Region VI does not provide industrial tap-water screening values, USEPA Region IV Guidance, which is included as Appendix C, was used to convert residential tap water risk-based concentrations (MSSLs) to industrial MSSLs (USEPA, 1994). Using this method, residential RBCs for VOCs are divided by 0.25 and RBCs for all other chemicals are divided by 0.5. RBCs were converted and presented in Table 1. Chemicals reported in perched groundwater were excluded from the HHRA if the reported maximum concentrations are less than the selected screening values.

Alluvial Groundwater

Although alluvial groundwater exposures are based on the inhalation pathway, the more stringent of risk-based concentrations for ingestion and MCLs were used to screen VOC concentrations in alluvial groundwater.

Soil (Surface and Subsurface) and Sediment

Reported maximum surface soil (0 to 1 foot bgs) and sediment concentrations were compared to residential MSSLs based on ingestion. For the industrial scenario, maximum reported surface and subsurface soil (all depths) concentrations were compared to industrial MSSLs based on ingestion. When necessary, chemicals that did not have a published MSSL were compared to a surrogate

MSSL. Surrogate compounds were selected based on structural, chemical, or toxicological similarities and are indicated on each screening table.

Subsurface Soil Screening Levels

Because chemicals present in subsurface soil may potentially leach to groundwater and act as a continuing source of groundwater contamination, subsurface data (all depths) were compared to site-specific soil screening levels (SSLs). A site-specific dilution attenuation factor of 1.05 was calculated using Equations 1 and 2 and assumptions regarding the hydrogeology of the site presented in the *Cedar Chemical Corporation Facility Investigation* (EnSafe, 1996).

$$dilution\ factor = 1 + \frac{Kid}{IL} \qquad \text{Equation 1}$$

$$d = \left(0.0112L^2\right)^{0.5} + d_a\left\{1 - \exp\left[(-LI) / Kid_a\right]\right\} \qquad \text{Equation 2}$$

Variables for Equations 1 and 2

- K = aquifer hydraulic conductivity (30,372 m/yr)(EnSafe, 1996)
- i = hydraulic gradient (0.00018 m/m)(EnSafe, 1996)
- I = infiltration rate (289 m/yr)(calculated assuming a permeability of 0.6 to 2 in/hr)
- d = mixing zone depth (calculated using Equation 2)
- L = source length parallel to ground water flow (12 m)(EnSafe, 1996)
- d_a = aquifer thickness (34.8 m)(EnSafe, 1996)

SSLs were calculated using Equations 3 and 4. The target concentrations used in Equation 4 is the MCL when available or the Region VI tap-water screening value. Site-specific SSLs are presented in Table 2.

$$C_t = C_w\left(K_d + \frac{\theta_w + \theta_a H'}{\rho_b}\right) \qquad \text{Equation 3}$$

$$C_t = C_w\left(\left(K_{oc}f_{oc}\right) + \frac{\theta_w + \theta_a H'}{\rho_b}\right) \qquad \text{Equation 4}$$

Variables for Equations 3 and 4

C_t = screening level in soil (mg/kg)
C_w = target soil leachate concentration (mg/L)
K_d = soil-water partition coefficient (L/kg) (chemical-specific)
θ_w = water-filled soil porosity (unitless) (0.3)
θ_a = air-filled soil porosity (unitless) (0.13)
ρ_b = dry soil bulk density (1.5 kg/L)
H' = dimensionless Henry's law constant (chemical-specific)
K_{oc} = soil organic carbon-water partition coefficient (L/kg) (chemical-specific)
f_{oc} = organic carbon content of soil (0.002 kg/kg)

2.2.3.2 Comparison of Data to Background Concentrations

Limited background surface soil samples were collected for CCC. No background samples were collected for subsurface soil and groundwater. Except for arsenic, background surface soil concentrations were determined for inorganics using results from three background sampling locations. The background concentration for these inorganics were established as the mean, plus two standard deviations. Table 3 presents background data.

Because additional surface soil samples were collected to assess background arsenic concentrations, an upper confidence limit of the arithmetic mean (95th UCL) was calculated using guidance provided by USEPA (USEPA, 1992b). Background sampling locations are presented in Figure 2. Detailed UCL calculations are presented in Appendix D.

After comparison to risk-based screening values, detected metals concentrations were compared to site-specific background concentrations. Only metals exceeding the MSSL and background concentrations were retained as COPCs.

2.2.3.3 Chemicals of Potential Concern

COPCs identified for soil and sediment at each of the eight sites are presented below.

Site	Surface Soil	Surface and Subsurface Soil	Sediment
Site 1	arsenic, dieldrin, 1,2-dichloroethane	arsenic, dieldrin, 1,2-dichloroethane	arsenic, chromium
Site 2	aldrin, dinoseb	arsenic, chromium, mercury, aldrin, dieldrin, 1,2-dichloroethane, chloroform, methylene chloride	none collected
Site 3	none collected	dinoseb	arsenic, aldrin, dieldrin, toxaphene, pentachlorophenol
Site 4	dieldrin, dinoseb	arsenic, dieldrin, dinoseb, 3,4-dichloroaniline, 1,2-dichloroethane	none collected
Site 5	none collected	No COPCs were identified.[a]	none collected
Site 6	aldrin, dieldrin, methoxychlor, toxaphene, dinoseb	none collected	none collected
Site 8	No COPCs were identified.	none collected	none collected
Site 9	heptachlor, dinoseb, 3,4-dichloroaniline, Propanil	arsenic, dinoseb, 3,4-dichloroaniline, Propanil	none collected

Note:

a = All sample depths for Site 5 exceed 10 feet. Because no receptors contact soil below 10 feet, no COPC were selected.

The following COPCs were identified for perched groundwater: arsenic, barium, cadmium, chromium, lead, 4,4'-DDT, alpha-BHC, 2,6-dinitrotoluene, 3,4-dichloroaniline, 4-chloroaniline, bis(2-chloroethyl)ether, dinoseb, 1,2-dichloroethane, 4-methyl-2-pentanone, acetone, benzene, chloroform, methylene chloride, and trichloroethene.

The COPCs identified for alluvial groundwater are: 1,1,2-trichloroethane, 1,2-dichloroethane, 1,2-dichloropropane, acetone, benzene, bromodichloromethane, chlorobenzene, chloroform, dibromochloromethane, methylene chloride, 4-methyl-2-pentanone, and toluene.

SSL Screening Results

Chemical concentrations exceeding site-specific SSLs are presented below.

Site	Chemical	Exceeds Site-Specific SSL	Detected in Perched Groundwater	Detected in Alluvial Groundwater	Leaching Ability
1	beta-BHC	Yes	No	No	NA
	Dieldrin	Yes	No	No	NA
	1,2-Dichloroethane	Yes	Yes	Yes	mobile
	Chloroform	Yes	Yes	Yes	mobile
2	Aldrin	Yes	No	No	NA
	alpha-BHC	Yes	Yes	No	low mobility
	Dieldrin	Yes	No	No	NA
	bis(2-Chloroethyl)ether	Yes	Yes	No	mobile
	Dinoseb	Yes	Yes	No	pH dependent; low pH = adsorption; high pH = mobile
	1,2-Dichloroethane	Yes	Yes	Yes	Yes
2	Chloroform	Yes	Yes	Yes	Yes
	Methylene chloride	Yes	Yes	Yes	Yes
3	Dinoseb	Yes	Yes	No	pH dependent; low pH = adsorption; high pH = mobile
4	Dieldrin	Yes	NA	No	NA
	3,4-Dichloroaniline	Yes	NA	No	NA
	Lead	Yes	Yes	No	NA
	Dinoseb	Yes	NA	No	pH dependent; low pH = adsorption; high pH = mobile
	Propanil	Yes	NA	No	NA

Site	Chemical	Exceeds Site-Specific SSL	Detected in Perched Groundwater	Detected in Alluvial Groundwater	Leaching Ability
5	Dinoseb	Yes	NA	No	pH dependent; low pH = adsorption; high pH = mobile
9	3,4-Dichloroaniline	Yes	NA	No	NA
	Dinoseb	Yes	NA	No	pH dependent; low pH = adsorption; high pH = mobile
	Propanil	Yes	NA	No	NA

Note:
NA = not applicable

SSLs are used to determine the potential for chemicals in soil to migrate to groundwater. Because SSLs do not address variables such as natural attenuation, the screening results are only a general indicator that migration will occur. The screening results indicate that the only chemicals likely to migrate to groundwater are the VOCs: 1,2-dichloroethane, bis(2-chloroethyl)ether, chloroform, and methylene chloride. Based on alluvial groundwater data, the only contaminants that have been detected in groundwater are the VOCs identified. Although the SSL data indicate that other contaminants may migrate to groundwater, this has not occurred. Only VOCs exceeding the SSLs and detected in alluvial groundwater will be quantitatively evaluated in the HHRA.

Screening perched groundwater data against SSLs indicates that the contaminant detections that exceed the MSSL are: 1,2-dichloroethane, alpha-BHC, bis(2-chloroethyl) ether, dinoseb, chloroform, and methyl chloride. Although the perched groundwater data indicate that chemicals have migrated, these chemicals are not likely to migrate to the alluvial aquifer because the two aquifers are not connected. All chemicals exceeding the SSL that are detected in perched groundwater will be quantitatively evaluated in the HHRA.

Detailed information identifying COPCs detected in soil, sediment, and groundwater samples is presented in the tables indicated below.

Tables 4-9	surface soil
Tables 10-15	subsurface soil
Table 16	perched groundwater
Table 17	alluvial groundwater
Tables 18 and 19	sediment

2.2.3.4

Identification of Transport Routes

Impacted media include surface soil, subsurface soil, sediment, perched groundwater, and alluvial groundwater. Air contamination is possible because of contaminated soil. Airborne COPCs were evaluated as volatiles and particulates. Concentrations of airborne chemicals from soil were calculated using guidance presented in *Soil Screening Guidance* (USEPA, 1996). Air contamination is also possible because of VOCs released to air from contaminated alluvial groundwater. Concentrations of airborne chemicals from both soil and groundwater were determined using the mathematical models presented in Section 2.3.2.

2.2.4 Concentrations to be Used in Risk Assessment

The exposure point concentration (EPC) is the concentration of a contaminant in an exposure medium that may be contacted by a receptor. EPCs were selected using suggestions provided in RAGS Part A. The upper confidence limit of the arithmetic mean (95% UCL) values was estimated using the State of Washington Department of Ecology Model Toxics Cleanup Act statistical software called MTCA*Stat* (Version 2.1). For data sets where a UCL could not be estimated, the maximum detected concentration was selected as the EPC by default. Generally, the maximum concentration was selected as the EPC for the following situations:

- the population of the data set was less than 10
- the 95% UCL was greater than the maximum detected concentration

For the construction worker scenario, which assumes construction activities will be restricted to depths of 10 feet bgs or less, the soil data sets for each site were evaluated to screen out analytical data for samples depths exceeding10 feet bgs. The construction worker scenario data set includes those samples collected between 0 and 10 feet. Because of this sample depth limitation, Site 5 subsurface soil was not evaluated for the construction worker scenario.

The 95% UCL was calculated using the statistical software based on the assumptions listed below when estimating the UCL:

- For nondetects, if the reported sample quantitation limit (SQL) or practical quantitation limit (PQL) exceeded the MSSL, one-half the SQL or one-half the PQL was used as the proxy value. The distribution of this modified data set was then determined. If the data distribution was lognormal, the *H*-statistic was used to estimate the UCL. If the data distribution was normal the *t*-statistic was used to estimate the UCL.

- For data distributions that were determined by the software to be neither normal nor lognormal, a lognormal distribution was assumed and the *H*-statistic was used to estimate the UCL (USEPA, 1992b).

Tables 20 to 33 present the EPC concentrations by site and media. Output tables from the MTCA*Stat* program are presented in Appendix D. Documentation and guidance for the MTCA*Stat* software are also provided in Appendix D. The software for this program can be obtained from http://www.wa.gov/ECOLOGY/tcp/mtcastat.html.

2.3 Exposure Assessment

The objective of the exposure assessment is to estimate the type and magnitude of exposures to the COPCs present at or migrating from a site. Results of the exposure assessment will be integrated with chemical-specific toxicity information to characterize human health risks potentially associated with the site.

2.3.1 Evaluation of Exposure Pathways

Exposure pathways describe the movement of chemicals from sources such as soil and groundwater to exposure points, where receptors (i.e., potentially exposed populations) may come in contact with chemicals. An exposure pathway is typically defined by four components.

Exposure Pathway Components

- A source and mechanism of chemical release to the environment.
- An environmental transport medium (e.g., air, water) for the released chemicals.
- Potential contact (exposure point) between a receptor and contaminated medium.
- An exposure route (e.g., inhalation, ingestion, dermal contact) at the exposure point.

An exposure pathway is considered complete only if all four components are present. In conducting a risk assessment, only complete exposure pathways are quantitatively evaluated. Exposure pathways that have been identified as potentially applicable to site conditions are presented in Section 2.3.1.3.

2.3.1.1 Physical Setting

Climate

Arkansas has a humid mesothermal climate characteristic of the southeast to south-central United States. Based on www.worldclimate.com, the average rainfall for Helena, Phillips County, is 51.8 inches per year, with the most precipitation occurring between December and May.

Phillips County is an attainment area for all primary and secondary air pollutants. The prevailing wind is southwest at an average speed of 8 mph and travels in that direction 12.3% of the time. The average temperatures are listed below.

Average Temperatures

- annual 60.8°F
- maximum 71.4°F
- minimum 50.2°F

Additional climatological data include:

- Heating degree days: The cumulative number of degrees in a month or year by which the mean temperature falls below 18.3°C/65°F.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
°C	466	353	227	77	19	0	0	0	8	80	223	396	1854
°F	839	635	409	139	34	0	0	0	14	144	401	713	3337

***Source*:**
www.worldclimate.com/cgi-bin/data.pl?ref=N34W090+1302+033242C.

- Cooling degree days: The cumulative number of degrees in a month or year by which the mean temperature is above 18.3°C/65°F.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
°C	0	0	5	27	105	210	273	244	142	32	0	0	1041
°F	0	0	9	49	189	378	491	439	256	58	0	0	1874

***Source*:**
www.worldclimate.com/cgi-bin/data.pl?ref=N34W090+1308+033242C

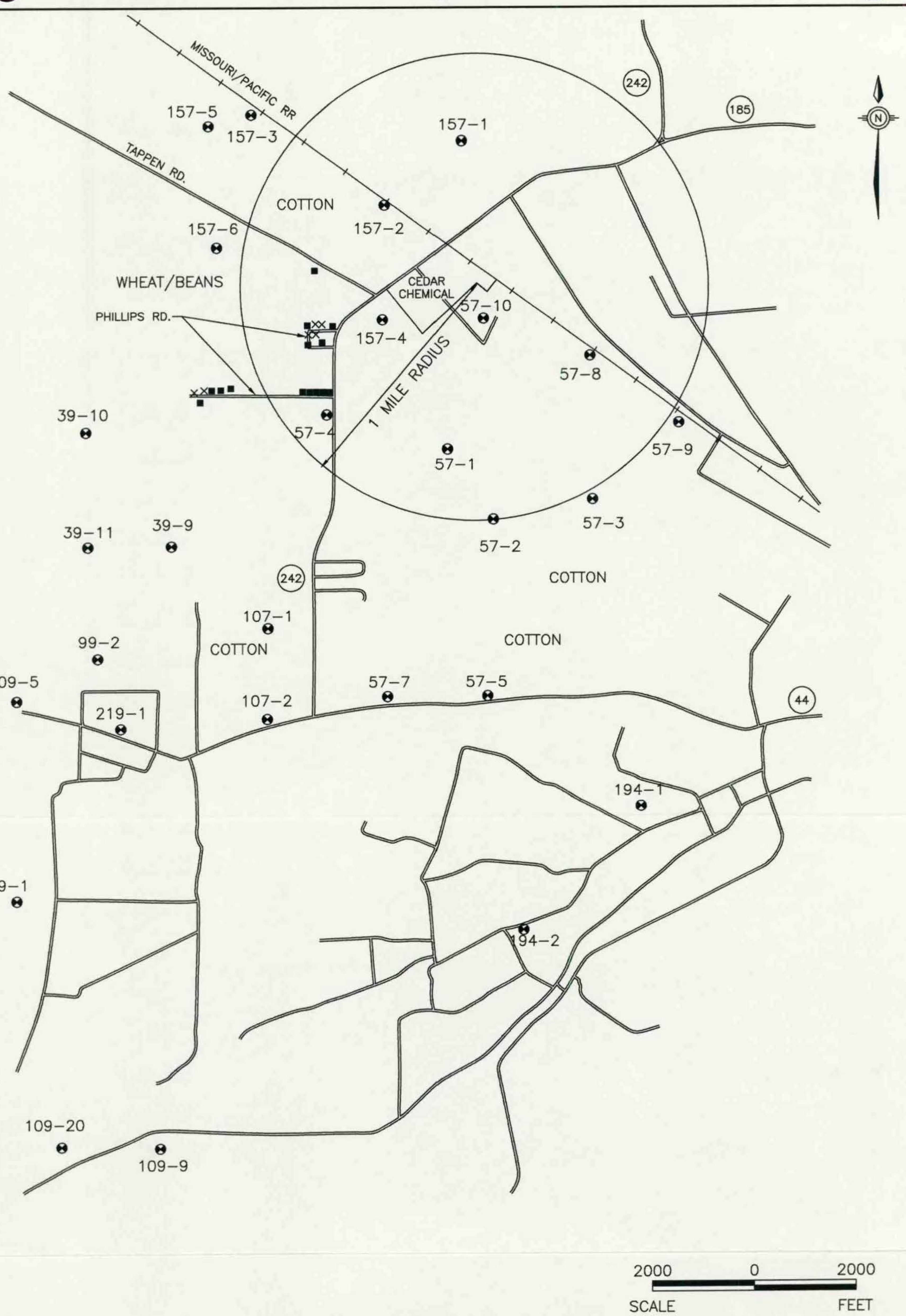
Output from the www.worldclimate.com website is provided in Appendix E.

Groundwater Uses

Onsite: The CCC plant receives water from two potable water supplies. The front offices, shower room, and laboratory receive potable water from the City of West Helena. The City of Helena supplies the rest of the plant. Both cities obtain groundwater from the Sparta Sand aquifer, which is a confined aquifer approximately 400 feet bgs (USGS, 2000 and EnSafe, 1996).

Offsite: During preparation of the 1995 *Interim Response Work Plan* (EnSafe, 1995), a well survey identified residential and agricultural wells near the site. The sections below describe the results of the residential and agricultural well survey. Figure 11 presents residential and agricultural wells near CCC.

Residential Wells: Nineteen residences down or cross gradient from the CCC facility were either visited or observed during the residential well survey. Several of the downgradient residences are within a 1-mile radius of the site, primarily on Phillips Road. Wells formerly supplied all residences with domestic water; however, all homes have been connected to the city water system for more than 10 years. Based on the 1995 survey and August 2000 followup, the wells are currently in various states of disrepair: some are capped, some are open with no pumps, others have unusable pumps. Because the wells do not function, water from them is not used. The text below indicates that none of the residences surveyed is currently using private wells as a source of general use water. If new residences were built on agricultural land surrounding CCC, these structures must receive drinking water from the City of Helena or City of West Helena.



LOCATIONS ARE APPROXIMATE

LEGEND

- ⊖ – AGRICULTURAL WELLS
- ■ – RESIDENTS INCLUDED IN WELL SURVEY
- × – RESIDENTS WITH WELLS, NOT IN SURVEY

ENSAFE
800–588–7962
MEMPHIS, TENNESSEE
CHARLESTON,SC; CINCINNATI,OH; DALLAS,TX; JACKSON,TN; KNOXVILLE,TN; LANCASTER,PA; NASHVILLE,TN; NORFOLK,VA; PADUCAH,KY; PENSACOLA,FL; RALEIGH,NC; COLOGNE, GERMANY

FIGURE 11
AGRICULTURAL AND RESIDENTIAL WELL LOCATIONS
CEDAR CHEMICAL
RISK ASSESSMENT

DWG DATE: 08/30/99	DWG NAME: 2162S009

Residential Well Survey Results

Address	Owner	On City Water?	Comments
14 Phillips Road (332)	Pat Lawson[a]	Yes	Well casing observed
34 Phillips Road (332)	—	Yes	Well casing, no pump
78 Phillips Road (332)	—	Yes	10 to 12 years on city water, pump does not work
98 Phillips Road (332)	R.A. Smith[a]	Yes	Well casing, no pump
444 Phillips Road (332)	James Larry, Sr.[a]	Yes	Well casing, no pump, well is capped
578 Phillips Road (332)	John Larry[a]	Yes	Well casing observed, well is capped
50 Phillips Road (330)	—	Yes	17 years on city water, well is capped
114 Phillips Road (330)	O'Neal	Yes	20 years on city water, well is capped
328 Phillips Road	Barton Truck	Yes	No wells
867 Phillips Road (326)	—	Yes	No known wells
28 Phillips Road	BPS	Yes	No production wells
876 Old Little Rock Road	—	Yes	No well
6962 Old Little Rock Road	—	Yes	On city water, no motor on pump
7122 Old Little Rock Road	—	Yes	No wells
—	Steel Sales	Yes	No wells
7994 Old Little Rock Road	–	Yes	No wells
8102 Old Little Rock Road	–	Yes	No wells

Notes:
— = No Data Available
a = Information regarding wells t these residences was obtained in August 2000. Respondents indicated that water from these wells was no longer used for any purpose.

Agricultural Wells: Data on agricultural wells near the site were obtained from the U.S. Department of Agriculture Soil Conservation Service extension office in Helena, Arkansas. These wells range from 120 to 125 feet deep, and are thus screened in the basal portion of the alluvial aquifer.

Thirteen wells within 1 to 2 miles of the site are used primarily to irrigate cotton fields. However, because crops are rotated in these areas, water from these wells could also be used to irrigate soybean and wheat fields (EnSafe, 1996).

Land-Use Conditions

Land use conditions in the immediate vicinity of the site are either agricultural or industrial (Figure 12). Specifically, the CCC site is bound by Arkansas Highway 242 to the northwest, a Union-Pacific railway to the northeast, and other industrial park properties to the southeast and southwest. The land across Highway 242 is agricultural. Residential areas are within one half mile southwest and northeast of the site.

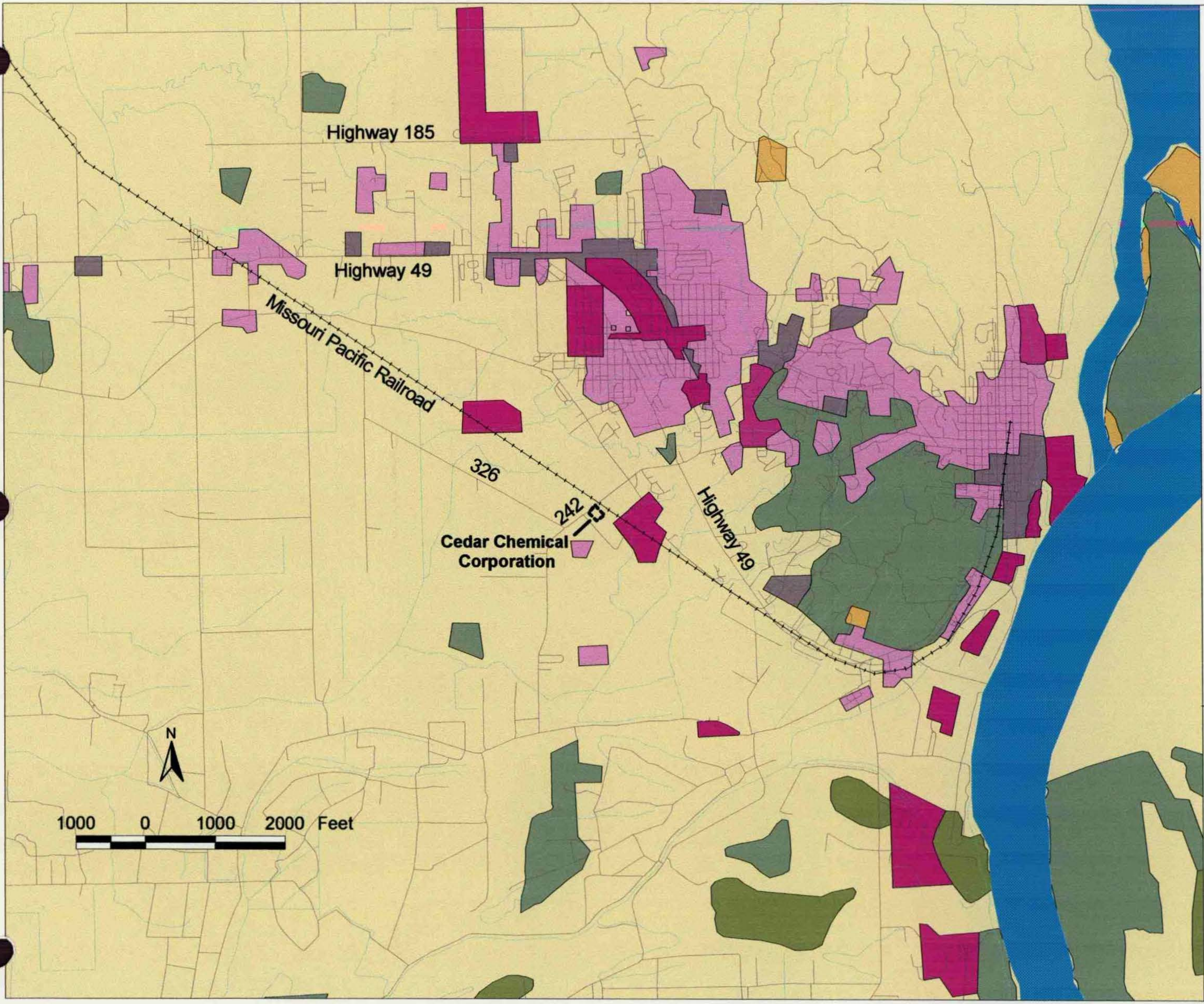
2.3.1.2 Exposure Points

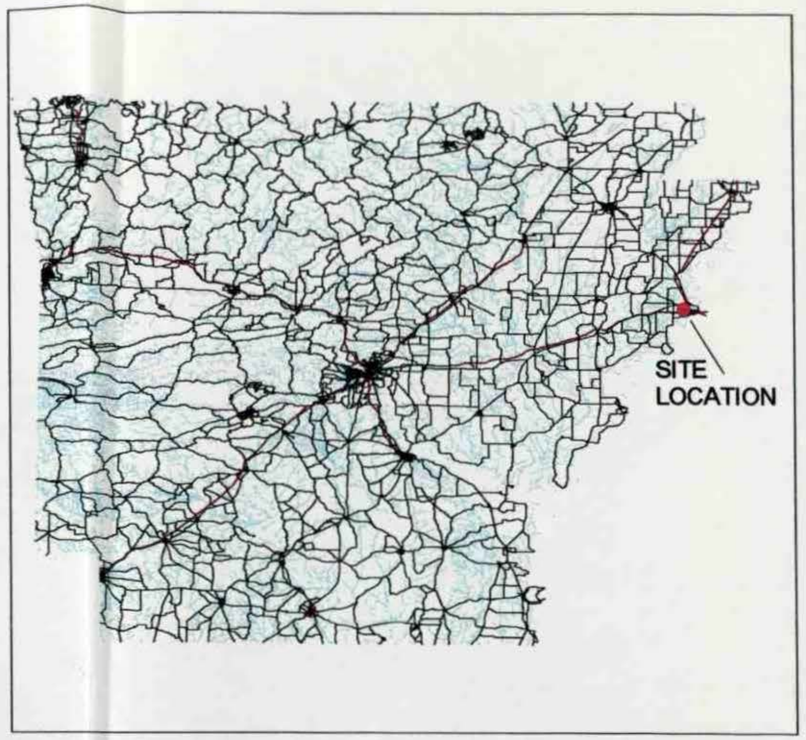
An exposure point is defined as a location of potential contact between a receptor and a chemical. For this risk assessment, it was conservatively assumed that COPCs were uniformly distributed throughout the individual sites. Exposure points identified for CCC are presented below.

Land-Use Scenario	Receptor	Exposure Point
Current/Future Trespasser	Adolescent Trespasser	Surface soil and Sediment
Current/Future Commercial/Industrial	Site Workers	Surface soil and Sediment
Future Commercial/Industrial	Construction Worker	Surface and subsurface soil Perched groundwater
Current/Future Agricultural	Offsite Agricultural Worker	Alluvial groundwater

Although alluvial groundwater is considered a drinking water source by ADEQ, it is not currently used for drinking water and no residential wells are in the alluvial aquifer have been identified. Currently alluvial groundwater is used for irrigation. All water for human consumption and general use is provided by the water departments for the cities of Helena and West Helena.

Additionally, if agricultural land within this area was changed to residential, new residences would be placed on city water (personal communication, City of Helena Clerk's Office, June 22, 2000). Because alluvial groundwater does not have a direct contact exposure point at the property boundary, it will not be evaluated for a residential land-use scenario.





EPA LAND-USE AND HELENA ZONING CLASSIFICATION

- AGRICULTURAL
- BARREN LAND
- FOREST LAND
- INDUSTRIAL / CENTRAL BUSINESS DISTRICT
- RESIDENTIAL
- HIGHWAY
- WATER
- WETLAND
- OTHER URBAN

- Streets
- Hydrology
- Railroad

CEDAR CHEMICAL CORPORATION
WEST HELENA, ARKANSAS

FIGURE 12
LANDUSE AND LANDCOVER MAP

ENSAFE

ENSAFE INC.
ENVIRONMENTAL AND
MANAGEMENT CONSULTANTS

D:/PROJECTS/HELENA_DIR/STATEPLANE/PROJ1.APR

2.3.1.3 Exposure Pathways

Exposure pathways describe modes of contact with an intake of the COPCs at the exposure points. COPC sources, locations, and types of activity patterns are assessed to determine significant pathways of exposure. Relevant pathways for receptors exposed to chemicals detected at CCC are presented below.

Receptors	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Site Workers	Air, Inhalation of gaseous contaminants released from soil	Yes	It is assumed that site workers will inhale gaseous contaminants from soil.
	Air, Inhalation of chemicals entrained in fugitive dust	Yes	It is assumed that site workers will inhale fugitive dust.
	Air, Inhalation of gaseous contaminants released from alluvial groundwater	No	Alluvial groundwater is not a water source at CCC.
	Surface Soil, Incidental ingestion	Yes	It is assumed that site workers will ingest incidental amounts of soil.
	Surface Soil, Dermal contact	Yes	It is assumed that site workers will have dermal contact with soil.
Offsite Workers	Air, Inhalation of gaseous contaminants released from alluvial groundwater	No	Alluvial groundwater is not a general or drinking water source at neighboring facilities. Site workers are either not present or within enclosed spaces during irrigation.

Receptors	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Future Land Uses			
Site Workers	Air, Inhalation of gaseous contaminants released from soil	Yes	It is assumed that site workers will inhale gaseous contaminants from soil.
	Air, Inhalation of chemicals entrained in fugitive dust	Yes	It is assumed that site workers will inhale fugitive dust.
	Air, Inhalation of gaseous contaminants released from alluvial groundwater	No	Alluvial groundwater is not a water source at CCC. Site workers are either not present or within enclosed spaces during irrigation.
	Surface Soil, Incidental ingestion	Yes	It is assumed that site workers will ingest incidental amounts of soil.
	Surface Soil, Dermal contact	Yes	It is assumed that site workers will have dermal contact with soil.
Offsite Workers	Air, Inhalation of gaseous contaminants released from alluvial groundwater	No	Alluvial groundwater is not a general or drinking water source at neighboring facilities. Site workers are either not present or within enclosed spaces during irrigation.
Future Onsite Construction Workers	Air, Inhalation of gaseous contaminants released from soil	Yes	It is assumed that construction workers will inhale gaseous contaminants from soil.
	Air, Inhalation of chemicals entrained in fugitive dust	Yes	It is assumed that construction workers will inhale fugitive dust.
	All soil depths, Incidental ingestion	Yes	It is assumed that site workers will ingest incidental amounts of soil.
	All soil depths, Dermal contact	Yes	It is assumed that site workers will have dermal contact with soil.
	Sediment, Incidental ingestion	Yes	It is assumed that site workers will ingest incidental amounts of sediment.
	Sediment, Dermal contact	Yes	It is assumed that site workers will have dermal contact with sediment.
	Perched groundwater, Incidental ingestion	Yes	It is assumed that site workers will ingest incidental amounts of perched groundwater.
	Perched groundwater, Dermal contact	Yes	It is assumed that site workers will have dermal contact with perched groundwater.
Future Offsite Agricultural Workers	Air, Inhalation of gaseous contaminants released from alluvial groundwater	Yes	It is conservatively assumed that farmers may inhale VOCs emanating from alluvial groundwater.
Future Site Trespassers (Adolescents, 7 through 16 years old)	Air, Inhalation of gaseous contaminants released from soil	Yes	It is assumed that trespassers will inhale gaseous contaminants from soil.
	Air, Inhalation of chemicals entrained in fugitive dust	Yes	It is assumed that trespassers will inhale fugitive dust.
	Surface Soil, Incidental ingestion	Yes	It is assumed that trespassers will ingest incidental amounts of soil.
	Surface Soil, Dermal contact	Yes	It is assumed that trespassers will have dermal contact with soil.
	Sediment, Incidental ingestion	Yes	It is assumed that trespassers will ingest incidental amounts of sediment.
	Sediment, Dermal contact	Yes	It is assumed that site workers will have dermal contact with sediment.

Because alluvial groundwater is used to irrigate crops, plants may absorb VOCs. Food crops grown on agricultural land adjacent to CCC include soybeans and wheat (EnSafe, 1996): both must be processed before humans or animals can ingestion them. Based on information from *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (USEPA, 1998), these crops represent aboveground produce with a protective covering on the edible portions of the plant. For these plants, the principal mechanism for plant uptake of VOCs is via vapor transfer. Although there are other mechanisms for contaminant uptake, e.g., root uptake and direct deposition of particles, these processes are not important for this scenario because contamination does not occur in soil and any VOCs in irrigated water are lost to volatilization. According to Jeff Yurk, the primary author of this guidance, USEPA assumes plant uptake of VOCs through any pathway (air, deposition, or roots) to be insignificant, because VOCs have low bioaccumulation factors and VOC levels are reduced during processing of crops after harvest. Therefore, risks associated with ingestion of contaminated produce were not evaluated for CCC.

2.3.2 Fate and Transport Modeling

Concentrations of airborne chemicals from soil were estimated using mathematical models to approximate fate and transport processes in the ambient environment.

Air Concentrations of VOCs and Particulates

Airborne chemicals from soil were evaluated as VOCs and fugitive dust. Concentrations of volatiles from soil were calculated using methods outlined in *Soil Screening Guidance: User's Guide* (USEPA, 1996), which require calculating chemical-specific soil-to-air volatilization factors (VFs). The calculation of VF values was completed using Equations 5 and 6, which are presented on the Soil Screening Level website (http://risk.lsd.ornl.gov/epa/ssl1.htm). The website was also used to calculate VFs. The results of these calculations are presented in Appendix F.

$$VF\left(m^3/kg\right) = \frac{Q/C \times \left(3.14 \times D_A \times T\right)^{1/2} \times 10^{-4}\left(m^2/cm^2\right)}{2 \times \rho_b \times D_A} \qquad \text{Equation 5}$$

where: $$D_A = \frac{\left[\left(\theta_a^{10/3} D_i H' + \theta_w^{10/3} D_w\right)/n^2\right]}{\rho_b K_d + \theta_w + \theta_a H'} \qquad \text{Equation 6}$$

where:

VF	=	volatilization factor (m^3/kg)
Q/C	=	inverse of mean concentration at center acre-square source (37.64 g/m^2-s per kg/m^3 for Little Rock)
D_A	=	apparent diffusivity (cm^2/s)(chemical-specific)
θ_a	=	air-filled soil porosity ($L_{air}/L_{soil} = n - \theta_w = 0.28$)
D_i	=	diffusivity in air (cm^2/s)(chemical-specific)
H'	=	dimensionless Henry's law constant (chemical-specific)
n	=	total soil porosity ($L_{pore}/L_{soil} = 1 - \rho_b/\rho_s = 0.43$)
D_w	=	diffusivity in water (chemical-specific)
K_d	=	soil-water partition coefficient ($cm^3/g = K_{oc} \times f_{oc}$)(chemical-specific)
K_{oc}	=	soil organic carbon partition coefficient (cm^3/g)(chemical-specific)
f_{oc}	=	fraction organic carbon (0.006 g/g)
ρ_b	=	dry soil bulk density (1.5 g/cm^3)
ρ_s	=	soil particle density (2.65 g/cm^3)
T	=	exposure interval (9.5E+08s)
θ_w	=	water-filled soil porosity (0.15 L_{water}/L_{soil})

The rate of fugitive dust emission from the soil surface depends upon various factors, including surface roughness and cloddiness, surface soil moisture content, type and amount of vegetative cover, wind velocity, etc. Concentrations of chemicals in fugitive dust particles from soil were calculated using the default particulate emission factor of 1.32E+09 m^3/kg which is presented in *Soil Screening Guidance: User's Guide* (USEPA, 1996).

Air Concentrations of VOCs in Alluvial Groundwater

Air concentrations associated with irrigation were estimated for COPCs in alluvial groundwater using the mathematical model described in Equations 7 to 9. These air concentrations were conservatively estimated based on exposure to one square acre of land at a temperature of 80°F and a wind speed of 1 m/sec. It is assumed that the land is supplied with an inch of water (102,800 liters) on a given day and that the contaminated water is supplying a constant molar flux from the water to the air over the square acre. The following equation, a solution of Fick's law, was used to calculate the molar flux.

$$N_A = \frac{P \times D_{AB} \; (p_{A1} - p_{A2})}{(z_2 - z_1) \; RT \; (p_B)_{lm}} \qquad \text{Equation 7}$$

where:

N_A	=	Molar Flux of 2-propanol (moles per square feet per pound [moles/ft^2 - lb])
P	=	Total pressure of system [14.7 pounds per square inch (psi)]
D_{AB}	=	Diffusion coefficient for each VOC (A) in air (B) (≅ 1E-05 square meters per second [m^2/sec])
p_{A1}	=	Partial pressure of VOC at point 1
p_{A2}	=	Partial pressure of VOC at point 2 (0 psi)
$(p_b)_{lm}$	=	Log mean of air pressure
z_2	=	Point 2 in feet (5 millimeters [mm])
z_1	=	Point 1 starting point of liquid (0 mm)
R	=	Gas Constant 10.73 (cubic feet-pounds per square inch/pound-mole-°Rankine
T	=	Temperature °R (80 °F)

The vapor pressure for each VOC was calculated using Henry's law, as described by Equation 8.

$$P_{vp} = H_c \times C_w \qquad \text{Equation 8}$$

where:

P_{vp} = Air vapor pressure (psi)
H_c = Henry's law constant (chemical-specific)
C_w = Concentration in water (milligrams per liter [mg/L])

The Henry's law constants were collected from the literature (Sawyer, 1994; Davis, 1998; DOE Risk Assessment Information System, http://risk.lsd.ornl.gov/rap_hp.htm). Air vapor pressure (P_{vp}) estimated using Equation 8 was substituted for P_{A2} in Equation 7.

USEPA's Screen Model Version 3 modeling was performed on each of the emission rates generated above to determine the maximum downwind concentrations. The maximum concentration predicted by this dispersion model are presented in Table 34.

2.3.3 Potentially Exposed Populations

The known or potential human receptors for current and future land use conditions include:

Current Land Use	Future Land Use
Onsite Workers	Construction Worker
Offsite Agricultural Worker	Adolescent Trespasser
	Offsite Agricultural Worker
	Onsite Workers

Although there is the possibility that industrial workers and future residents located on property adjacent to CCC may be exposed to volatile contaminants emanating from groundwater during irrigation events, potential risks associated with these receptors are substantially lower than for the agricultural worker because residential receptors and workers are either in enclosed spaces or not present during irrigation. Therefore, risks to this receptor were not evaluated.

It is unlikely that the surrounding property will be developed for residential use in the foreseeable future based on census data presented below for the cities of Helena and West Helena

(U.S. Department of Commerce, 2000). Population estimates for the years 1990 to 1998, which are presented below, indicate that neither city will experience drastic increases in population. Therefore, it is not likely that county agricultural land will be required for additional housing units.

Population Estimates for Places: Annual Time Series, July 1, 1990, to July 1, 1998

	Estimated Population									
	7/1/98	**7/1/97**	**7/1/96**	**7/1/95**	**7/1/94**	**7/1/93**	**7/1/92**	**7/1/91**	**7/1/90**	**4/1/90**
Helena	6,970	7,081	7,069	7,158	7,237	7,261	7,279	7,307	7,475	7,491
West Helena	9,443	9,576	9,639	9,742	9,835	9,841	9,855	9,896	10,114	10,137

***Source*:**
Population Estimates Program, Population Division, U.S. Census Bureau, Washington, DC 20233 (Internet Release Date: June 30 1999).

2.3.4 Quantification of Intakes

Estimates of exposure to COPCs are required for quantitative risk characterization. The basic equation used to calculate the human intake is as follows:

$$Intake = C \times \frac{CR \times EF \times ED}{BW \times AT} \qquad \text{Equation 9}$$

where:

Intake	=	daily intake (milligrams per kilogram per day [mg/kg-day])
C	=	concentration of the chemical (e.g., milligram per kilogram [mg/kg] in soil, milligrams per liter [mg/L] in water or milligram per cubic meter [mg/m^3] in air)
CR	=	contact rate; the amount of contaminated medium contacted over the exposure period (e.g., milligram per day [mg/day] for soil, liters per day [L/day] for water, and cubic meters per day [m^3/day] for air)
EF	=	exposure frequency; describes how often exposure occurs (days/year)
ED	=	exposure duration; describes how long exposure occurs (years)
BW	=	body weight; the average body weight over the exposure period (kilograms [kg])
AT	=	averaging time; period over which exposure is averaged (days)

Each of the intake variables in the equation above have a range of values. The intake model variables used generally reflect 50th or 95th percentile values which, when applied to the exposure point concentration (EPC), ensure that the estimated intakes represent the reasonable maximum exposure (RME). Formulas were derived from RAGS, Part A unless otherwise indicated.

The pathway-specific intake formulas, variables, and calculations are presented for each receptor. For the adult worker, trespasser, construction worker, and offsite agricultural worker two different types of tables are presented. The first presents the formula, assumed input values, associated references, and relevant comments. This table should be consulted for details and rationale regarding the parameter values used in the calculations. Each variable table is immediately followed by tables presenting the actual calculations using the information in the variable table. For clarity, each variable of the intake equation is included in the calculation tables. The tables are numbered as follows:

	Soil	**Sediment**	**Groundwater**
Construction Worker	Tables 35-38	Tables 39-41	Tables 42-44
Site Worker	Tables 45-48	NA	NA
Adolescent Trespasser	Tables 49-52	Tables 53-55	NA
Offsite Agricultural Worker	NA	NA	Tables 56-57

Because site worker exposure at Site 4 differs from all other CCC sites, the exposure parameters used to develop pathway-specific intake factors were adjusted to account for site-specific exposure patterns. For Site 4, it was assumed that the workers were exposed only during shipping and receiving activities. Tables outlining pathway-specific intake formulas, variables, and calculations are presented in Appendix A.

2.4 Toxicity Assessment

The objectives of the toxicity assessment are to evaluate the potential for particular contaminants to cause adverse effects in exposed individuals and to provide the analytical framework for the characterizing human health impacts.

2.4.1 Toxicological Information for Noncarcinogenic Effects

To assess noncarcinogenic risks, the USEPA has adopted the science policy position that protective mechanisms such as repair, detoxification, and compensation must be overcome before the adverse health effect is manifested. Therefore, a range of exposures exists from zero to some finite value that can be tolerated by an organism without appreciable risk of expressing adverse effects.

USEPA gauges potential noncarcinogenic effects by identifying the upper boundary of the tolerance range (threshold) for each chemical and deriving an exposure estimate below which adverse health effects are not expected to occur. Such an estimate for the oral exposure route is called an oral reference dose (RfD); for the inhalation exposure route it is an inhalation reference concentration (RfC). The oral RfD is typically expressed as milligrams (mg) chemical per kilograms (kg) body weight per day, and the inhalation RfC is usually expressed as concentrations in air (i.e., mg chemical per m^3 of air). However, for this risk assessment, inhalation RfC values can be converted to dosage units by multiplying them by the inhalation rate (20 m^3/day, an upper-bound estimate for combined indoor-outdoor activity) and dividing by the body weight (70 kg, average adult body weight):

$$RfD_{inhalation} = \frac{RfC \times IR_{inhalation}}{BW} \qquad \text{Equation 10}$$

where:

$RfD_{inhalation}$	=	Inhalation reference dose (mg/kg-day)
RfC	=	Reference concentration (mg/m^3)
$IR_{inhalation}$	=	Inhalation rate (m^3/day)
BW	=	Body weight (kg)

Two types of oral RfDs/inhalation RfCs are available from the USEPA; which are based on length of exposure. Chronic oral RfDs/inhalation RfCs are specifically developed to protect against long-term exposure to a compound, and are generally used to evaluate the noncarcinogenic effects associated with exposure periods between seven years (approximately 10% of a human lifetime) and a lifetime. Subchronic oral RfDs/inhalation RfCs are useful for characterizing potential noncarcinogenic effects associated with shorter-term exposures. As a current guideline for Superfund program risk assessment, subchronic oral RfDs/inhalation RfCs are used to evaluate potential noncarcinogenic effects of exposure periods between two weeks and seven years.

The toxicological criteria used to evaluate the noncarcinogenic health effects potentially associated with exposure to chemicals of concern are presented in Tables 58 (oral route) and Table 59 (inhalation route). Relevant information, such as most sensitive target organs and/or systems, uncertainty factors used as basis for the derivation of toxicological criteria, and information sources, are also included.

No toxicological criteria are currently available to gauge potential human health concerns associated with the dermal exposure route. For risk assessment purposes, oral RfDs are recommended as the default dermal RfDs (USEPA 1989a), if:

- Health effects following exposure are not route-specific.
- Portal-of-entry effects (e.g., dermatitis from dermal exposure and respiratory effects from inhalation exposure) are not the principal effects of concern.

Exposure through the dermal route is generally calculated as an absorbed dose, while oral RfDs are expressed as administered doses. Therefore, adjustments are necessary to match the dermal exposure estimates with the oral RfDs. Current USEPA Superfund guidance is to adjust the oral RfD with an oral absorption factor (i.e., percentage of the chemical absorbed) to extrapolate a default dermal RfD, which is expressed in terms of absorbed dose. The equation for extrapolation of a default dermal RfD is:

$$RfD_{dermal} = RfD_{oral} \times Oral\ Absorption\ Factor \qquad \text{Equation 11}$$

where:

RfD_{dermal}	=	Dermal reference dose (absorbed dose in mg/kg-day)
RfD_{oral}	=	Oral reference dose (administered dose in mg/kg-day)

The default dermal RfDs and the oral absorption factors used in calculations are presented in Table 58.

2.4.2 Toxicological Information for Carcinogenic Effects

To assess risks associated with potential carcinogens, the USEPA has adopted the science policy position of "no-threshold," i.e., there is essentially no level of exposure to a carcinogen that will not result in some finite possibility of tumor formation.

The USEPA has formed a Carcinogen Risk Assessment Verification Endeavor (CRAVE) work group. Its purpose is to evaluate the weight of evidence using available carcinogenicity data to estimate excess lifetime cancer risks from various levels of exposure to potential human carcinogens by establishing weight-of-evidence classifications and developing numerical carcinogenic risk estimates (slope factors or unit risks).

The weight-of-evidence classification assigned to a potential carcinogen by USEPA estimates of the likelihood that an agent is a human carcinogen, based on best professional judgment of the quality of available data. The classification does not affect numerical carcinogenic estimates. USEPA classifications are outlined below:

> ***Group A chemicals (human carcinogens):*** There is sufficient evidence to support a causal association between human exposure and cancer.
>
> ***Groups B1 and B2 chemicals (probable human carcinogens):*** There is limited (B1) or inadequate (B2) evidence of carcinogenicity based on human studies. Group B2 agents are also generally supported by carcinogenicity data in animal studies.
>
> ***Group C chemicals (possible human carcinogens):*** There is limited evidence of carcinogenicity in animals.
>
> ***Group D chemicals (i.e., not classifiable as to human carcinogenicity):*** These are chemicals for which there is inadequate human and animal evidence of carcinogenicity, or for which no data are available. Numerical carcinogenic risk estimates are not typically calculated for Group D chemicals because of the lack of pertinent dose-response data.
>
> ***Group E chemicals (i.e., evidence of non-carcinogenicity in humans):*** There is no evidence of carcinogenicity from adequate human or animal data.

Two types of quantitative estimates are available from CRAVE for evaluating carcinogenic potency associated with oral exposure: slope factor, expressed in terms of risk per unit dose (as units of $[mg/kg\text{-}day]^{-1}$), and unit risk, expressed as risk per unit concentration in drinking water (micrograms per liter $[\mu g/L]^{-1}$).

Inhalation unit risks (an expression of carcinogenic risk per unit concentration in air) are verified by USEPA's CRAVE work group as a numerical estimate of the carcinogenic risks associated with inhalation exposure to carcinogens. The inhalation slope factors (an expression of carcinogenic risk per unit dose) calculated by the USEPA were removed from the Integrated Risk Information System (IRIS) in January 1991 because CRAVE believed that the concentration in air, rather than the total body dose, was a better index of inhalation exposure. To facilitate quantitative risk assessment, the current Superfund guidance is to convert an inhalation unit risk to a body dose, as directed in the Health Effects Assessment Summary Tables (HEAST), by using the following equation:

$$SF_{inhalation} = \frac{UR_{inhalation} \times BW \times CF}{IR_{inhalation}} \qquad \text{Equation 12}$$

where:

$SF_{inhalation}$	=	Inhalation slope factor $(mg/kg\text{-}day)^{-1}$
$UR_{inhalation}$	=	Inhalation unit risk (micrograms per cubic meter $[\mu g/m^3]^{-1}$)
$IR_{inhalation}$	=	Upper bound estimate of inhalation rate (20 m^3/day)
CF	=	Conversion factor (micrograms per milligram [μg/mg])

Toxicological information for the carcinogenic health concern related to the chemicals selected for the quantitative risk assessment is presented in Table 60 (oral route)and Table 61 (inhalation route). These tables present carcinogenic weight-of-evidence classifications, quantitative cancer potency estimates (i.e., oral slope factors and inhalation unit risks), primary tumor sites that have been reported, and information sources.

Current USEPA Superfund guidance for calculating a dermal slope factor is to adjust the oral slope factor with an oral absorption factor specific to that chemical, using the following equation:

$$SF_{dermal} = \frac{SF_{oral}}{Oral\ Absorption\ Factor}$$ Equation 13

where:

SF_{dermal} = Dermal slope factor $(mg/kg\text{-}day)^{-1}$
SF_{oral} = Oral slope factor $(mg/kg\text{-}day)^{-1}$

The default dermal slope factors for the chemicals of concern, along with the oral absorption factors used are presented in Table 60.

2.5 Risk Characterization

This step of the risk assessment integrates information from the exposure and toxicity assessments (Sections 3 and 4) to characterize potential risks posed by site COPCs.

Risk characterization methodology follows these steps:

- Organize exposure and toxicity assessments outputs by the duration and exposure route for each population.
- Quantify total carcinogenic and noncarcinogenic risks for each pathway by summing the estimated risks estimated for each COPC.
- Estimate overall risks affecting each population over the same time period by combining risks across pathways.
- Analyze and discuss inherent risk characterization uncertainties.

2.5.1 Quantification of Noncarcinogenic Risk

Noncarcinogenic risk is expressed as an HQ, which is the ratio of the exposure intake (calculated in the exposure assessment) over the reference dose (acceptable intake indicated by oral RfD or inhalation reference value from the toxicity assessment). An HQ less than or equal to 1 indicates that an individual is unlikely to experience adverse health effects from exposure to the COPC (USEPA, 1989). The HQ is calculated as follows:

$$HQ = \frac{DI}{RfD} \qquad \text{Equation 14}$$

where:

HQ	=	hazard quotient (unitless)
DI	=	daily intake (mg/kg-day)
RfD	=	reference dose (mg/kg-day)

A hazard index (HI) is calculated by summing the HQs to address noncarcinogenic additive effects between chemicals and cumulative effects across all exposure routes.

2.5.2 Quantification of Carcinogenic Risk

Carcinogenic risk is characterized by calculating a CR probability. The CR is a unitless incremental probability of an individual developing cancer from a lifetime exposure to a COPC (USEPA, 1989). For low risk levels (below estimated risk of 0.01), the CR is calculated by multiplying the exposure intake (calculated in the exposure assessment) by the cancer slope factor (from the toxicity assessment). The criterion typically used by regulatory agencies for demonstration of no carcinogen risk of concern is a CR of less than one in a million. A CR is calculated as follows:

$$CR = DI \times SF \qquad \text{Equation 15}$$

where:

CR = cancer risk (unitless)
DI = daily intake (mg/kg-day)
SF = slope factor $(\text{mg/kg-day})^{-1}$

To address multiple chemicals, the additive carcinogenic effects of chemicals and cumulative effects across all routes of exposure were addressed by summing the individual CRs.

$$CR_{SITE} = CR_{PATHWAY_A} + CR_{PATHWAY_B} + CR_{PATHWAY_C}\cdots \qquad \text{Equation 16}$$

where:

CR_{SITE} = Sum of cancer risk calculated for COPCs in each pathway
$CR_{PATHWAY}$ = Cancer risk for each applicable exposure pathway

2.5.3 Results of Risk Characterization

Results of the risk characterization are presented for each land-use condition and exposure pathway in the following tables in Appendix A:

Site	Tables
1	62A-64E
2	65A-67C
3	68A-69C
4	70A-72C
6	73A-75C
9	76A-78C
Offsite	79A-79C

2.5.3.1 Discussions of Risk Characterization

Regulatory agencies have developed criteria for the demonstration of carcinogenic and noncarcinogenic risks. A CR ranging between one in one million (1×10^{-6} or 1E-06) and one in ten thousand (1×10^{-4} or 1E-04) is currently used by USEPA as the target risk level for carcinogenic effects, whereas an HI of 1 is used as the target risk level for noncarcinogenic effects. Tables 80 to 83 summarize those carcinogenic and noncarcinogenic risks exceeding 1E-06 and 1 for each site and receptor.

Except for alluvial groundwater exposure for the offsite agricultural worker carcinogenic risk for the remaining media (perched groundwater, sediment and soil) have cumulative CRs that are less than 1E-04. The construction worker and trespasser carcinogenic risks are less than 1E-04.

Groundwater carcinogenic risk for alluvial groundwater is 7E-04. The primary contributors to cancer risk are 1,2-dichloroethane (5E-04) nad methylene chloride (2E-04).

Tables 80 to 83 summarize the noncarcinogenic risks exceeding unity for each receptor. HIs for several sites exceed unity, suggesting that COPCs may pose adverse noncarcinogenic impact to receptors evaluated in the HHRA. The construction worker (Table 80) soil exposures exceed unity for perched groundwater and at Sites 2, 3, 4, and 9. The primary contributor to the soil HQ is dinoseb (Sites 3, 4, and 9) and 1,2-dichloroethane at Site 2. 4-Chloroaniline, 1,2-dichloroethane, and methylene chloride are the primary contributors to HQ for perched groundwater.

Table 80 lists the noncarcinogenic risks exceeding unity for the adult worker exposure to surface soil. At Site 9 dinoseb is the primary contributor to noncarcinogenic risk.

Table 81 presents noncarcinogenic risks exceeding 1 for the trespasser. Site 9 is the only site with unacceptable noncarcinogenic risk. The primary contributors are dinoseb and propanil.

Table 82 presents those noncarcinogenic risks exceeding unity for the offsite agricultural worker exposure to airborne VOCs released from alluvial groundwater. Methylene chloride, toluene, 1,2-dichloroethane, chlorobenzene, and 1,2-dichloropropane are the primary contributors to noncarcinogenic risk.

2.5.4 Chemicals of Concern Identified by Site and Media

A contaminant was selected as a COC if its CR exceeded 1E-6 or it had an HQ greater than 1. COCs are listed below by site and media:

Site	Surface Soil	Subsurface Soil	Sediment
1	None	None	Arsenic
2	None	1,2-Dichloroethane	NA
3	NA	Dinoseb	None
4	None	3,4-Dichloroaniline, Dinoseb	NA
6	None	NA	NA
9	Dinoseb, Propanil	Dinoseb, Propanil	NA
Perched Groundwater		4-Chloroaniline, 3,4-Dichloroaniline, 1,2-Dichloroethane, Methylene chloride	
Alluvial Groundwater		Benzene, Chloroform, Methylene Chloride, 1,2-Dichloroethane, and Toluene	

2.5.5 Central Tendency Evaluation

Where RME estimates of risk indicated a significant threat (CR greater than 1E-4 or an HQ greater than 1) would be posed to human health, central tendency (CT) analysis was performed. The CT analysis uses the arithmetic mean concentration as the EPC and 50th percentile exposure assumptions that are consistent with guidance provided in *Exposure Factor's Handbook* (USEPA, 1997). Central tendency exposures are presented for comparison to risks associated with RME exposure.

A CT evaluation was completed for the following sites, media, and chemicals.

Receptor	Site	Media	Chemicals
Construction Worker	1 & 2	Perched Groundwater	4-Chloroaniline, 3,4-Dichloroaniline, 1,2-Dichloroethane, Methylene chloride
	3	Surface and Subsurface Soil	Dinoseb
	4	Surface and Subsurface Soil	3,4-Dichloroaniline, Dinoseb
	9	Surface and Subsurface Soil	3,4-Dichloroaniline, Dinoseb, Propanil
Adult Worker	9	Surface Soil	Dinoseb, Propanil
Trespasser	9	Surface Soil	Dinoseb, Propanil
Offsite Agricultural Worker	—	Alluvial Groundwater	Methylene chloride, 1,2-Dichloroethane, Toluene

Tables 83 to 89 summarize present risks calculated for CT exposure. Intake factor calculations used to develop the CT exposure are presented in Appendix G.

Construction Worker

Tables 83A to 83C present the noncarcinogenic and carcinogenic risks for the construction worker exposed to perched groundwater. Using CT exposure assumptions, carcinogenic risks are below threshold levels. Noncarcinogenic risk to 3,4-dichloroaniline remain greater than 1.

Tables 84A to 84C present the noncarcinogenic risks for the construction worker exposed to dinoseb in subsurface soil at Site 3. Noncarcinogenic risk has been reduced to less than 1 using CT exposure assumptions.

Tables 85A to 85C present the noncarcinogenic risks for the construction worker exposed to 3,4-dichloroaniline (9) and dinoseb (3) in surface and subsurface soil at Site 4. Using CT exposure assumptions noncarcinogenic risks remain above 1.

Tables 86A to 86C present the noncarcinogenic risks for the construction worker exposed to 3,4-dichloroaniline, dinoseb, and propanil in Site 9 surface and subsurface soil. Using CT exposure assumptions noncarcinogenic risks are less than 1.

Adult Worker

Tables 87A to 87C present the noncarcinogenic risk for the adult worker exposed to dinoseb in Site 9 surface soil. Using CT exposure assumptions, noncarcinogenic risks remain greater than 1.

Trespasser

Tables 88A to 88C present the noncarcinogenic risks for the trespasser exposed to dinoseb and propanil in Site 9 surface soil. Using CT exposure assumptions noncarcinogenic risks remain greater than 1.

Offsite Agricultural Worker

Tables 89A to 89C present the noncarcinogenic and carcinogenic risks for the offsite agricultural worker exposed to VOCs released from alluvial groundwater during irrigation. Using CT exposure assumptions, noncarcinogenic risks are less than 1. Carcinogenic risk is 5E-05 and the primary contributor to risk is 1,2-dichloroethane. However, te risk of 5E-05 is within the USEPA threshold range of 1E-06 to 1E-04. Because the magnitude of risk associated with exposures to 1,2-dichloroethane is greater than 1E-02, risk was calculated using the one-hit equation as presented in RAGS Part A.

2.5.6 Discussion of Uncertainty

2.5.6.1 Data Evaluation Uncertainties

A conservative approach was used to review available analytical data and select COPCs for the quantitative risk assessment. The selection of a compound as a COPC does not necessarily suggest that it poses a human health or environmental concern for the site under investigation. Inclusion of a chemical in the quantitative risk assessment only indicates a need for further examination of the compound determine if there are any risks from exposure to this chemical.

Three background surface soil samples were collected at CCC. Because of the lack of information associated with background metals concentrations, it is unknown whether lead should be a COC. The lack of data identifying the naturally occurring levels of arsenic in native soil and lead in alluvial groundwater upgradient of CCC represents a data gap and could lead to an overestimate of risk.

Concentrations used in the risk assessment were conservatively determined. It was assumed that the chemicals in soil occurred uniformly on ground surface. Because of this conservative approach, actual site risks are expected to be substantially lower than those risks estimated in this risk assessment.

2.5.6.2 Exposure Assessment Uncertainties

Uncertainties in the exposure assessment could arise from the following sources:

- Use of standard assumptions instead of site-specific data selected on the basis of "best professional judgment."

- Selection of a value from a wide range reported in published literature thought to best represent the site under study.

- The degree of "protectiveness" or "conservatism" inherent in the current risk assessment guidance.

- Lack of sufficient data and necessary assumptions made in order to complete the quantitative risk assessment.

The types and sources of exposure uncertainties are outlined below.

Calculation of Exposure Point Concentrations

A conservative approach was used to estimate the concentrations at the point of exposure, not considering degradation of any chemicals in the environmental media. Because it has been well recognized that many organic chemicals can degrade in the environment, this conservative approach is expected to result in an overestimate of risk.

Selection of Exposure Pathways

Although not considered likely in the actual environmental situation, it was assumed that the population of concern could simultaneously be exposed to multiple chemicals through all possible pathways. This conservative assumption is anticipated to overestimate potential site risks.

Exposure Parameter Values for Each Pathway

To conduct a quantitative exposure assessment, many assumptions must be made concerning the exposure scenarios (e.g., frequency and duration of exposure, intake rate of contaminated media). Site-specific values are often unavailable and the using default values (primarily upper-bound estimates) is likely to contribute to exposure assessment uncertainty. For the hypothetical future scenarios (i.e., industrial and residential exposures), default values used in the exposure assessment are worst-case values and overestimate exposure. Summarized below are examples of uncertainties related to the selection of parameter values:

Soil Inhalation Pathway

Inhalation rate (the volume of air inhaled per unit period of time) can vary according to an individual's age, weight, sex, activity level and general physical condition. In accordance with USEPA guidance (USEPA, 1991), the default inhalation rate of 20 m^3/day or 0.83 m^3/hr was used in the risk assessment for adult receptors. This value is considered to be an upper-bound value for adults representing inhalation during active hours. Values of 13.3 m^3/day (equivalent to 0.55 m^3/hr) and 8.7 m^3/day (equivalent to 0.36 m^3/hr) are recommended, respectively, by USEPA as the average daily inhalation rate for adults and children (between ages of 1 and 12) for continuous exposure in which specific activity patterns are not known (USEPA, 1997). Therefore, use of the default value is expected to overestimate potential inhalation risk.

Ingestion Pathway

In accordance with USEPA guidance (USEPA, 1991), the following combined soil and dust ingestion rates were used in this risk assessment: 50 mg/day (for adolescent trespassers and site workers) and 480 mg/day (for construction workers).

There are no reliable data for estimating adult soil ingestion rates. A soil ingestion rate of 50 mg/day for adults in commercial/industrial setting is recommended as a standard default value (USEPA,1991), which is based on a preliminary adult soil ingestion study by Calabrese (1991). However, Calabrese and Stanek have since determined that the soil ingestion rates reported in their preliminary study were invalid, and that the previously derived ingestion rate of 50 mg/day is an overestimation (Calabrese and Stanek, 1991).

USEPA does not provide default soil ingestion values for a trespassing scenario. In the absence of this information, soil and sediment ingestion was estimated to be 50 mg/day.

In summary, the soil ingestion rates currently recommended by USEPA (i.e., 50 mg/day for adolescent trespassers and adults in a commercial/industrial environment and 480 mg/day for construction workers) are overly conservative and not supported by the scientific literature. Therefore, use of these default soil ingestion rates in the site-wide risk assessment is expected to result in an overestimation of risk.

Dermal Pathway

Exposed Skin Area — The amount of chemical intake correlates directly with the exposed skin surface area. Climatic conditions could determine the type of clothing worn, and thus the skin area exposed. USEPA currently recommends that 5% of the skin is exposed during winter, 10% during spring and fall, and 25% during summer (USEPA, 1996b). Assuming an adult body surface area of 20,000 cm^2, exposed skin surface areas would be: 1,000 cm^2 in winter, 2,000 cm^2 in spring and fall, and 5,000 cm^2 in summer.

For CCC exposed skin surface areas of 2,900 cm^2 and 4,100 cm^2 were selected for evaluating dermal exposures to soil for a child and adult (residential and industrial) populations. These values represent 20% of the body surface, assuming an individual is wearing a short-sleeved shirt, long pants, and shoes with only the head (1,400 cm^2), hands (1,120 cm^2), and forearms (1,570 cm^2) exposed. For the trespasser, the exposed skin surface is assumed to be 2,900 cm^2. This is based on 20% of the total body surface for an adolescent ages 7 to 16 years old. The values used are conservative for these scenarios.

Soil-to-Skin Adherence Factor (AF) — A default AF value of 1 mg/cm^2 is recommended by USEPA for estimating intake of chemicals in soil via dermal exposure route (USEPA, 1995). This value was first provided in a USEPA report as an upper-bound estimate (USEPA, 1992a). Available studies indicate that adherence levels vary considerably with the type of activities and across different parts of the body (USEPA, 1997). Because the AF was not adjusted to account for these variables, risk associated with dermal contact exposure is most likely overestimated.

Absorption Factor (ABS) — Very limited information is available concerning dermal absorption of chemicals from contaminated soil under realistic environmental conditions. In fact, there are no actual epidemiological data to support the current USEPA position that absorption of soil-bound organics under realistic exposure conditions constitutes a complete pathway.

Region IV USEPA (USEPA, 1995a) requires that ABS values be based on the following default values: organics, 1 percent and inorganics: 0.1 percent. For the development of Region VI MSSLs, ABS values of 10 percent for organics and 1 percent for inorganics are used. It should be emphasized that information to support chemical-specific ABS is only available for the following chemicals: cadmium: 1 percent; PCBs: 6 percent; TCDD: 3 percent (low organic soil) and 0.1 percent (high organic soil); other dioxins: 3 percent (USEPA, 1992a). According to the recently released *Soil Screening Guidance* (USEPA, 1996c), pentachlorophenol is the only chemical among the 110 compounds evaluated to show greater than 10 percent dermal absorption. Therefore, quantification of dermal pathways has been deferred in several USEPA documents (USEPA, 1992a, 1996b) pending development of adequate data and methodology.

Because the ABS values suggested by Region VI USEPA are considered to be highly conservative in light of existing data, these recommended ABS values were not used in this risk assessment to calculate chemical intake in soil through direct dermal contact. Region IV USEPA ABS values were considered to be comparable to the values presented most recently in the literature. The ABS database for chemicals encountered as media contaminants is limited; therefore, using these default values could overestimate or underestimate risk associated with dermal exposure.

Groundwater Inhalation Pathway

Exposure Frequency: Inhalation of VOCs from groundwater for the offsite agricultural worker is a site-specific exposure pathway. The exposure frequency represents the number of irrigation events during a growing season. Information from the Phillips County Cooperative Extension Service indicates that irrigation occurs 7 to 10 days per month (average 8.5 days) during a growing season which begins in late April and ends in September. Assuming crops are irrigated 2.1 days in April and 8.5 days for the remaining months, the total irrigation events per year is 44.6 days.

The number of irrigation events depends on climate and the type of crop irrigated. Some crops might require more irrigation during the growing season than others, suggesting that the EF selected may result in an overestimate of risks to agricultural workers.

Exposure Time: The exposure time represents the time the agricultural worker is present during irrigation events. Because this is a site-specific scenario, limited information is available to address this parameter. However, it was conservatively assumed that the agricultural worker would be present four at least 4 hours during irrigation events. Generally, irrigation systems are automated and do not require the presence of an operator during operation. Most systems are put into operation and the agricultural worker then leaves the field. Therefore risks associated with this exposure time are most likely overestimated.

Concentration in Air: Mathematical models were used to estimate the concentrations of VOCs that emanate from groundwater during irrigation. The groundwater concentrations used for modeling are from wells installed both on the CCC property and just beyond the property boundary. No samples were collected from the agricultural wells used for irrigation. It was assumed that contaminants would move downgradient of the site, resulting in contamination of the agricultural wells. Because it is unknown if these contaminants are undergoing natural attenuation, the concentrations used for this model may overestimate risk. The lack of VOC data from the agricultural wells is a data gap.

2.5.6.3 Toxicity Assessment Uncertainties

Uncertainties in the quantitative toxicity assessment are well recognized, but the degree can vary depending on the major sources of uncertainty for a particular site. The types of toxicity information uncertainties for this risk assessment are outlined below.

Uncertainties Inherent in the Risk Assessment Process

- Use of animal data to predict potential human health effects.

- Extrapolation of effects observed in animals exposed to high doses to probable outcomes in humans following exposure to low environmental contaminant levels.

- A conservative approach to calculate toxicological criteria such as the oral and dermal RfD and inhalation RfC with uncertainty spans of perhaps one order of magnitude. These estimates can change when additional information becomes available. The carcinogenic slope factors and unit risks are typically calculated by the USEPA using a linearized multistage model, which leads to a plausible upper-bound estimate of the risk, although the true value of the risk is unknown and may be as low as zero (USEPA, 1986).

Uncertainties Common to Current EPA Guidance on Risk Assessment

- Lack of pertinent toxicological data for the chemicals selected for the quantitative risk assessment. For this risk assessment, 3,4-dichloroaniline was retained as a COC. The risks calculated for this compound were derived using 4-chloroaniline toxicity values as surrogates. Currently, 3,4-dichloroaniline does not have published toxicity values and the information available describing its toxicity is limited. 4-Chloroaniline was used as a surrogate based on similarities in structure. Therefore, the risk presented for this compound is uncertain.

- Lack of specific toxicity criteria to evaluate of the dermal exposure route. The current USEPA default position is to adjust the oral toxicity value with an oral absorption factor and adopt this adjusted value as the surrogate dermal toxicity value. The validity and scientific basis for this extrapolation warrant further deliberation, because the mechanism for absorption through a skin barrier (i.e., the dermal route) is expected to be different than absorption through a gastrointestinal system (i.e., the oral route). However, the current method recommended by USEPA to extrapolate default dermal toxicity values does not reflect the specific conditions under which the reference toxicological study was conducted (e.g., method of administration such as gavage, water, or diet, and vehicle of administration such as solvent, oil, or solution).

2.5.6.4 Uncertainties Specific to this Site

- Sites 1, 5, 6, and 8 are primarily pavement or gravel areas; therefore, surface soil exposures for the adult workers and trespassers would be minimized. Risks estimated for these areas are most likely overestimated.

- Perched groundwater exposure would most likely occur only if this water table were infiltrated during construction activities. Additionally, depending on the volume of water present, construction activities may cease until the water is removed. Risks associated with construction worker exposure to perched groundwater are highly conservative and are most likely overestimated.

- Access to CCC is controlled using fences, guards, and checkpoints. Trespassing onto the site is not likely; therefore, trespasser risk is most likely overestimated.

- Future land use for the site and the adjacent properties will most likely remain commercial/industrial or agricultural. If the site were to be used for future residential or agricultural purposes, it would need to be reevaluated for those land-use scenarios.

- The estimated VOC concentrations in air are applicable using the assumptions defined for the model used. However, given the variability in irrigation rates, the types of irrigation devices used, differences in irrigation methods, and changes in climate, the calculated VOC concentration in air could be an overestimate of the actual concentration.

- The mathematical model used to estimate VOC concentrations released from alluvial groundwater is based on a model that does not take into account any affects dispersion to the atmosphere might have on airborne VOC concentrations. This would indicate that the airborne VOC concentrations are most likely overestimated.

- Estimates VOC concentrations in air are based on concentrations of VOCs in alluvial groundwater samples collected onsite or a considerable distance upgradient of the closest irrigation well where VOC concentrations would be expected to be higher. No samples were collected from downgradient agricultural wells, resulting in a data gap. Because VOC concentrations in the agricultural wells are unknown, the actual risk associated with VOCs released from alluvial groundwater is uncertain. However, the risk estimates calculated using current onsite data most likely overestimate risk.

3

3.0 ECOLOGICAL EVALUATION

The ecological risk assessment (ERA) is a key component of the baseline risk evaluation. Its purpose is to develop a qualitative and/or quantitative ecological appraisal of the actual and/or potential effects of CCC contamination on the surrounding ecosystem. The assessment considers environmental media and exposure pathways that could result in unacceptable levels of exposure to flora and fauna currently or in the foreseeable future. The approach to assessing risk components was based on *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997) and *Framework for Ecological Risk Assessment* (USEPA, 1992c).

3.1 Problem Formulation

Environmental Setting

For the ecological risk assessment only, three areas of concern were identified. Area I consists of three onsite ditches that make up the storm water retention system. Area II consists of an approximately 2-acre isolated wetland on the southwest boundary of the plant property. Area III includes all adjacent offsite nonindustrial areas.

Area I

Area I consists of three onsite ditches which serve as a storm water retention system. This retention system is a component of the waste water treatment system identified as Site 3 in Figure 5. Storm water collected in these ditches is used in the wastewater treatment system as required by the facility's National Pollution Discharge Elimination System (NPDES) permit. These open ditches are vegetated with various grasses along the edges and submergent plants are present in the more frequently inundated portions. During the June 4, 1999, ecological survey two species of tadpoles (Bullfrog, *[Rana catesbeiana]* and Southern leopard frog, *[Rana utricularia]*) were observed in the ditches. Two species of birds were also feeding in and around the ditches. The killdeer *(Charadrius vociferus)*, a farm country plover, usually inhabits fields, airports, lawns, river banks, shores and the green heron *(Butorides striatus)* feeds on fish, frogs, crawfish, insects, and other aquatic life.

Area II

Area II consists of an approximately 2-acre wetland constructed in 1978 to serve as an overflow retention pond for the waste water treatment system (Figure 3). After the pond was excavated, it was realized that an overflow system was not necessary; therefore, a connection between the treatment system and the ponds was never installed. Over the years, the excavated area developed wetland characteristics through natural secession and now meets the Corps of Engineers definition of a wetland. The dominant wetland vegetation consists of black willow *(Salix nigra),* Chickasaw plum *(Prunus angustifolia),* common cattails (*Typha latifolia*), floating primrose willow (*Ludwgia spp.)* and duckweed (*Lemna spp*.)

Area III

Area III includes offsite nonindustrial areas within one mile of the facility (see Figure 11). These areas include agriculture farm lands, ditches, and tributaries to Big Creek. The tributaries discharge into Big Creek is approximately 15 miles southeast of the facility.

Approximately 99% of Area III is cultivated with cotton and soybeans, in the fall/winter, most fields have a cover crop of winter wheat.

3.2 Threatened and Endangered Species

Based on information from the Arkansas Game & Fish Commission and the Arkansas Natural Heritage Commission, 16 state and federal listed threatened and endangered species are in Phillips County (Appendix H). None has been identified in or around the site because of the area's heavy industrialized/agricultural use. These findings were confirmed by the Arkansas Natural Heritage Commission files and database search, which identified no occurrence of rare plants and animals, outstanding natural communities, natural or scenic rivers, or other elements of special concern within a 1-mile radius of the Cedar Chemical Company. A copy of this letter is presented in Appendix H .

3.3 Selection of Ecological Chemicals of Potential Concern

Ecological chemicals of potential concern (ECPC) from historic site activities have been identified and quantified using USEPA's methods and protocols for sediment analyses. For this assessment, only sediment samples were reviewed. No surface soil samples pertain to any of the three identified ecological areas. At Area I, only sediment samples were collected. At Area II, one geoprobe borehole was installed and both water and soil were collected. Area III sampling consisted of deep subsurface soil samples and groundwater. Because ecological risk is usually associated with only the top 6 inches of soil and no contaminant pathway exist for offsite surface soil, soil was not considered. Groundwater will be discussed later in this assessment, but no potential exposure pathway has ever been sampled. Because offsite agriculture wells may complete the pathway, they will be discussed. For the ERA, the USEPA's Region IV Supplemental Guidance to RAGS Bulletins and the Office of Solid Waste and Emergency Response (OSWER) sediment screening values were used to select potential ECPCs.

To identify chemicals that may pose a risk to the environment, the ERA used only the results from surficial sediment samples (0 to 6 inches bgs). It is presumed, even considering root development in the lower strata, that most biological effects are limited to this upper zone. In sediment, analytes were selected as an ECPC if the maximum concentration detected either: (1) exceeded the USEPA Region IV Sediment Screening Value and/or OSWER Values, (2) exceeded the most conservative effects level found in literature, or (3) if neither of these benchmarks were available.

3.4 Chemicals in Sediments

To present sediment conditions at Area I, the range of concentrations detected in sediments, the total number of samples analyzed (N), the number of detections, the minimum and maximum concentration for each parameter, the EPA Sediment Screening Value (SSV) and the ECPCs retained for consideration in the area-specific risk assessment are tabulated below.

3.5 Contaminants of Concern

To be conservative, ecological risk evaluations assume exposure to the maximum concentrations for each detected contaminant of concern.

In Area I, all chemicals were designated as ECPCs because maximum concentrations exceeded the sediment screening values.

In the Area II wetland, no sample data were collected because no exposure pathway was identified between the suspected source and the wetland was identified.

Area III sample data consist of subsurface soil and groundwater data only therefore, risk to terrestrial receptors could not be assessed. No ecological benchmarks exist for contaminated groundwater and ecological receptors are unlikely to be exposed to subsurface soil.

Cedar Chemical Corporation
Area I
Ditch Sediment Concentrations

					OSWER		
Parameter	**N**	**Detections**	**Range**	**SSV**	**Value**	**Type**	**ECPC**
METALS (ppm)							
Arsenic	12	1	20	7.24	8.2	ER-L	Yes

Cedar Chemical Corporation
Area I
Ditch Sediment Concentrations

Parameter	N	Detections	Range	SSV	OSWER Value	OSWER Type	ECPC
PESTICIDES (ppb)							
Aldrin	12	4	2.8-58	—	—	—	Yes
Dieldrin	12	4	5.6-550	3.3	52	SQC	Yes
4,4'-DDE	12	6	2-78	3.3	—	—	Yes
4,4'-DDD	12	9	7.6-180	3.3	—	—	Yes
4,4'-DDT	12	2	15-91	3.3	—	—	Yes
Endrin	12	2	76-89	3.3	20	SQC	Yes
gamma-BHC	12	1	18	3.3	3.7	SQB	Yes
Methoxychlor	12	6	130-2500	—	19	SQB	Yes
Toxaphene	12	1	1600	—	28	SQB	Yes

Notes:
N = Number of samples
SSV = USEPA Region IV Sediment Screening Value
ER-L = Effects Range-Low
SQC = Sediment Quality Criteria
SQB = Sediment Quality Benchmark

3.6 Characteristics of ECPCs

Inorganics

Arsenic was detected in one sample at 20 parts per million (ppm), which exceeds the SSV of 7.24 ppm. Soil biota appear to be capable of tolerating and metabolizing relatively high concentrations (microbiota to 1,600 ppm) of arsenic (Wang et al., 1984), but adverse effects to aquatic organisms have been reported at concentrations of 19 to 48 parts per billion (ppb) in water. Arsenic soil does not appear to magnify along the aquatic food chain.

Organics

Organochlorine pesticides have been used extensively in the United States since the 1940s and they appear to be ubiquitous in the environment, that is, they are present in surface water, sediment, and biological tissues. They are readily absorbed by warm-blooded species and degradatory products are frequently more toxic than the parent form. In soil invertebrates, organochlorine pesticides can accumulate to concentrations higher than those in the surrounding soil, and residues may be ingested by birds and other animals feeding on earthworms (Beyer and Gish, 1980). Most environmental effects studies have been directed at mammals and birds.

3.7 Exposure Pathways and Assessment

In Area I, all chemicals were selected as ECPCs because they either exceeded the sediment screening values or did not have a respective screening value. Two potential pathways were identified. Tadpoles in the ditches are exposed to contaminated sediments. The tadpoles could be bioaccumulating pesticides from exposure to contaminated sediments. Piscivorus birds could also ingest potentially contaminated tadpoles.

In Area II, no potential pathways were identified.

In Area III, the potential pathway from crop irrigation using contaminated groundwater has been identified because irrigation wells have not been sampled, no data are available to assess risk.

3.8 Ecological Effects Assessment

A screening-level risk evaluation has been conducted for wildlife potentially living in the Area I ditches. Potential dietary exposure has not been calculated due to lack of amphibian toxicity information from literature searches. A comparison between the sediment concentrations and available SSVs determined potential for any adverse effects.

Although two potential pathways have been identified, in Area I, the predicted ecological risk is less significant because storm water retention ditches are a component of the waste water treatment system. Storm water collected in the ditches is held until it is needed to treat the facility's process water discharged into the waste water treatment system. During the summer months 35,000 to 40,000 gallons of water are pumped into the treatment system each day. During dry summer months, the reserve storm water is depleted very fast and the ditches remain dry most of the summer. In late spring and early summer, the ditches hold water for longer periods and are used by opportunistic species such as frogs and wading birds. The ditches are dry until the fall and no longer provide suitable habitat. This short-term exposure to opportunistic species presents only marginal risk exposure. Area I is also in the middle of a heavily industrialized area and its discharge was designed to meet NPDES requirements. All treated water from Area I ditches has passed the same biomonitoring test as the effluent discharge from the waste water treatment system. Appendix I contains copies of the most recent biomonitoring report from the effluent discharge and a sample taken from the treatment ponds themselves.

Area II has been excluded from a detailed evaluation because no complete pathway exist, based on site visits and historical data.

Area III has one potential pathway that consists of contaminated groundwater being introduced to the surface by agriculture irrigation wells. Although wildlife could be at risk from contaminated groundwater, it is highly unlikely.

First, the downgradient agriculture wells have never been sampled and exact chemical concentrations are unknown.

Second, only VOCs have been detected in the most downgradient monitoring well. If present in the agriculture wells, the contaminant of concern, 1,2-dichloroethane would most likely evaporate due to relatively high vapor pressure when released to the land. Releases to the atmosphere would degrade by reaction with hydroxyl radicals. Given the poor degradation characteristics of 1,2-dichloroethane, the primary attenuation mechanisms are evaporation and natural attenuation through advection, diffusion, and dispersion.

Third, no viable habitat is present in Area III. Only a few populations of small mammal and passerine birds species are present. During the hot summer months when irrigations is most frequent, wildlife species are dormant during the heat of the day and seek refuge in wooded areas. Significant wildlife exposure to contaminated groundwater during irrigation is not anticipated.

4

4.0 REMEDIAL GOAL OPTIONS

RGOs are site-specific chemical concentrations used by risk managers during the development of remedial alternatives. They are calculated to equate with specific target carcinogenic and noncarcinogenic risk levels. For this HHRA, RGOs were calculated for chemicals having an ILCR greater than 1E-6 or an HQ greater than 1. Those COCs which required calculation of RGOs are listed in Section 2.5.4. Inclusion in the RGO table does not necessarily indicate that remedial action will be required to address a specific chemical. Instead, RGOs are provided to facilitate risk-management decisions.

In accordance with USEPA Region IV Supplemental Guidance (USEPA, 1995a), RGOs were calculated at 1E-6, 1E-5, and 1E-4 risk levels for carcinogenic COCs and HQ levels of 0.1, 1, and 3 for noncarcinogenic COCs for all applicable media and receptors using the following equations:

$$RGO_{NCR} = \frac{EPC \times THQ}{Calculated\ HQ} \qquad \text{Equation 17}$$

$$RGO_{CR} = \frac{EPC \times TR}{Calculated\ CR} \qquad \text{Equation 18}$$

where:

RGO_{NCR}	=	noncarcinogenic remedial goal option (unitless)
EPC	=	exposure point concentration (mg/kg)
THQ	=	target hazard quotient (0.1, 1, 3) (unitless)
HQ	=	hazard quotient (unitless)
RGO_{CR}	=	carcinogenic remedial goal option (unitless)
TR	=	target carcinogenic risk (1E-06, 1E-05, 1E-04)
CR	=	cancer risk (unitless)

RGOs are presented for sediment, surface and subsurface soil, surface soil, perched groundwater, and alluvial groundwater in the following tables:

Table Number	Site	Media	Receptor
90	1	Sediment	Construction Worker Trespasser
91	2	Surface and Subsurface Soil	Construction Worker
92	3	Subsurface Soil	Construction Worker
93	3	Surface and Subsurface Soil	Construction Worker
94	9	Surface Soil	Adult Worker Trespasser
94	9	Surface and Subsurface Soil	Construction Worker
95	1 & 2	Perched Groundwater	Construction Worker
96	NA	Alluvial Groundwater	Offsite Agricultural Worker

5.0 CONCLUSIONS

Alluvial groundwater risks based on RME for the offsite agricultural worker are the only cancer risks that are above 1E-04 for this facility. However, these risks are most likely overestimated because the concentrations of VOCs in offsite alluvial groundwater (at the agricultural wells) are unknown, VOCs are highly volatile and are most likely lost to the atmosphere during irrigation, workers are either not present or present for limited time periods during irrigation, which indicates that the exposure frequency and duration is overestimated. Noncarcinogenic risks for the RME for all receptors are substantially high. The highest risks are to construction workers exposed to dinoseb in surface and subsurface soil at Sites 3, 4, and 9.

For ecological receptors, potential risk in Area I is considered acceptable because these ditches are integral components of the facility's waste water treatment system. Because of the ditches function, standing water is frequently drained and any aquatic habitat is considered opportunistic. The isolated wetland in Area II is not considered at risk because the exposure pathway is incomplete. Risk to ecological receptors in Area III from exposure to contaminated groundwater resulting from farm irrigation is considered minimal based on the lack of receptors and the high volatility of 1,2-dichloroethane. No threatened and endangered species were present within a 1-mile radius of the site. This was confirmed by the Arkansas Natural Heritage Commission.

6

6.0 REFERENCES

Beyer, W.N. and C. D. Gish. (1980). Persistence in Earthworms and Potential Hazards to Birds of Soil Applied DDT, Dieldrin and Heptachlor. *Journal of Applied Ecology*. 17:295-307.

Calabrese et al., (1991). How Much Soil Do Young Children Ingest: An Epidemiologic Study. In E.J. Calabrese and P.T. Kostecki (Eds). *Petroleum Contaminated Soils*. 2(29). Lewis, Chelsea, MI.

Calabrese, E.J. and E.J. Stanek. (1991). A Guide to Interpreting Soil Ingestion Studies. II. Qualitative and Quantitative Evidence of Soil Ingestion. *Regul. Toxicol. Pharmacol.* 13:278-292.

EnSafe Inc. (1995, April 10). *Interim Response Work Plan, Cedar Chemical Corporation, West Helena, Arkansas*. Memphis, TN.

EnSafe Inc. (1996, June 28). *Facility Investigation Cedar Chemical Corporation — FINAL.* Memphis, TN.

EnSafe Inc. (1998). *Risk Assessment Work Plan, Cedar Chemical Corporation*. Memphis, TN.

USEPA. (1986). *Guidelines for Carcinogenic Risk Assessment*. EPA/600/8-87/045. August 1987.

USEPA. (1989, December). *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)*. Interim Final. (EPA/540/1-89/002).

USEPA. (1991, March 25). *Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors."* Interim Final. OSWER Directive 9285.6-03.

USEPA. (1992a, September 23, 1992). *Human Health Evaluation Manual, Supplemental Guidance: "Interim Dermal Risk Assessment Guidance."*

USEPA. (1992b). *Supplemental Guidance to RAGS: Calculating the Concentration Term.* OSWER. Washington, DC. (9285.7-081).

USEPA. (1992c, February). *Framework for Ecological Risk Assessment.* Risk Assessment Forum, Washington, D.C. EPA/630/R-92/001.

USEPA. (1994, November 22). *Amended Guidance on Preliminary Risk Evaluations (PREs) for the Purpose of Reaching a Finding of Suitability to Lease.*

USEPA. (1995a). *EPA Region IV: Supplemental Guidance to RAGS: Bulletins 1-4.* Office of Health Assessment — Waste Management Division: Atlanta, GA.

USEPA. (1995b). *Screening Method for Estimating Inhalation Exposure to Volatile Chemicals from Domestic Water.* Exposure Assessment Group — Office of Health Effects Assessment: Washington, DC.

USEPA. (1995c). *Supplemental Guidance to RAGS: Region IV Bulletins, Ecological Risk Assessment* — Draft. Waste Management Division, Office of Health Assessment, November.

USEPA. (1996, April). *Soil Screening Guidance: User's Guide.* OSWER: Washington, DC. (PB96-963505).

USEPA. (1997a, August). Exposure Factor Handbook. Office of Emergency and Remedial Response. Washington, DC. EPA/600/P-95/002A.

USEPA. (1997b). *Health Effects Assessment Summary Tables, Annual 1995 with Supplement.* Office of Emergency and Remedial Response, Washington, DC (PB95-921199).

USEPA. (1997c). *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments.* USEPA, Envir. Response Team: Edison, NJ.

USEPA. (1998a). *Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments).* Interim. Office of Emergency and Remedial Response: Washington, DC (PB9285.7-01D).

USEPA. (1998b, October). Region VI Human Health Medium-Specific Screening Levels. USEPA Region VI: Dallas, TX.

USEPA. (1998c). *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.*

Wang, D.S., R.W. Weaver, and J.R. Melton. (1984). *Microbial Decomposition of Plant Tissue Contaminate with Arsenic and Mercury.* Environmental Pollution 34A:275-282.

6.0 REFERENCES

Beyer, W.N. and C. D. Gish. (1980). Persistence in Earthworms and Potential Hazards to Birds of Soil Applied DDT, Dieldrin and Heptachlor. *Journal of Applied Ecology*. 17:295-307.

Calabrese et al., (1991). How Much Soil Do Young Children Ingest: An Epidemiologic Study. In E.J. Calabrese and P.T. Kostecki (Eds). *Petroleum Contaminated Soils*. 2(29). Lewis, Chelsea, MI.

Calabrese, E.J. and E.J. Stanek. (1991). A Guide to Interpreting Soil Ingestion Studies. II. Qualitative and Quantitative Evidence of Soil Ingestion. *Regul. Toxicol. Pharmacol.* 13:278-292.

EnSafe Inc. (1995, April 10). *Interim Response Work Plan, Cedar Chemical Corporation, West Helena, Arkansas*. Memphis, TN.

EnSafe Inc. (1996, June 28). *Facility Investigation Cedar Chemical Corporation — Final.* Memphis, TN.

EnSafe Inc. (1998). *Risk Assessment Work Plan, Cedar Chemical Corporation*. Memphis, TN.

USEPA. (1986). *Guidelines for Carcinogenic Risk Assessment*. EPA/600/8-87/045. August 1987.

USEPA. (1989, December). *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)*. Interim Final. (EPA/540/1-89/002).